Cascade Reservoir Watershed

Phase III Water Quality Management Plan

CR TAC and WAG Draft

Idaho Department of Environmental Quality

January 2004

Cascade Reservoir Watershed
Phase III Water Quality Management Plan

January 2004

Prepared by:
Cascade Satellite Office
Boise Regional Office
Idaho Department of Environmental Quality
1445 North Orchard
Boise, Idaho 83706

Acknowledgments

Hundreds of hours have been expended in the preparation of this and the preceding documents by volunteers, State and Federal agency personnel and many others. DEQ gratefully acknowledges the time and effort that have been dedicated by so many individuals and organizations whose help and support have been indispensable. Their continuing support is very much appreciated, indeed, critical to the success of this project. The help we have received in collecting and evaluating data, and in developing and reviewing this phased TMDL has been invaluable! Local citizens, governments, municipalities and industries throughout the Cascade Reservoir Watershed and North Fork Payette River Basin have been instrumental in guiding the development of this TMDL.

We would like to acknowledge the efforts of local citizens, county governments, local industries, municipalities, watershed councils, irrigation districts and companies, including Boise and Payette National Forests (USFS), Boise Cascade Corporation, the Idaho Soil Conservation Commission, the Idaho Department of Agriculture, the Idaho Department of Fish and Game, the Idaho Department of Lands, the Idaho Department of Parks and Recreation, the Idaho Department of Water Resources, the Natural Resources Conservation Service, the US Bureau of Reclamation, the Valley Soil and Water Conservation District, Valley County, the City of Cascade, the City of McCall, the City of Donnelly, the Big Payette Lake Water Quality Council and Technical Advisory Committee and the Lake Cascade Association for their participation in meetings, contributions of important background information, application for and administration of implementation project funding and their assistance with management and implementation of the water quality projects currently in-progress today.

On behalf of the DEQ, we wish to expressly acknowledge the Cascade Reservoir Coordinating Council, the Technical Advisory Committee and all the Source Plan workgroups for their continued, unflagging support of this effort. For over ten years these dedicated individuals have spent an extraordinary amount of time discussing challenging issues, reviewing draft documents, and driving over long roads often in inclement weather to attend meetings. Their value of their guidance, insight, and experience cannot be measured. We would like to extend our heartfelt gratitude to all of these individuals and look forward to a continued opportunity to work together as this project progresses.

Finally, we thank the citizens of the State of Idaho and surrounding states for their support of the recreational attributes of Cascade Reservoir, and their expressed concern and participation in its restoration.

Table of Contents

List of Tables

List of Figures

Abbreviations, Acronyms, and Symbols

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired waterbodies required by this section
µ	micro, one-one thousandth
§	Section (usually a section of federal or state rules or statutes)
AWS	agricultural water supply
BAG	Basin Advisory Group
BLM	United States Bureau of Land Management
BMP	best management practice
BOD	biochemical oxygen demand
BOR	United States Bureau of Reclamation
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
cfs	cubic feet per second
cm	centimeters
CWA	Clean Water Act
CWAL	cold water aquatic life
DEQ	Department of Environmental Quality
DO	dissolved oxygen
DOI	U.S. Department of the Interior
DWS	domestic water supply
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FPA	Idaho Forest Practices Act
FWS	U.S. Fish and Wildlife Service
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
I.C.	Idaho Code
IDAPA	Refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
IDWR	Idaho Department of Water Resources
INFISH	The federal Inland Native Fish Strategy
km	kilometer

km^2 square kilometer

LA load allocation

LC load capacity

m meter

m^3 cubic meter

mi mile

mi^2 square miles

MBI macroinvertebrate index

MGD million gallons per day

mg/L milligrams per liter

mm millimeter

MOS margin of safety

MWMT maximum weekly maximum temperature

n.a. not applicable

NA not assessed

NB natural background

nd no data (data not available)

NFS not fully supporting

NPDES National Pollutant Discharge Elimination System

NRCS Natural Resources Conservation Service

NTU nephlometric turbidity unit

ORW Outstanding Resource Water

PACFISH The federal Pacific Anadromous Fish Strategy

PCR primary contact recreation

PFC proper functioning condition

ppm part(s) per million

QA quality assurance

QC quality control

RHCA riparian habitat conservation area

SBA subbasin assessment

SCR secondary contact recreation

SFI DEQ's stream fish index

SHI DEQ's stream habitat index

SMI DEQ's stream macroinvertebrate index

SRP soluble reactive phosphorus

SS salmonid spawning

SSOC stream segment of concern

TDG total dissolved gas

TDS total dissolved solids

T&E threatened and/or endangered species

TIN total inorganic nitrogen

TKN total Kjeldahl nitrogen

TMDL total maximum daily load

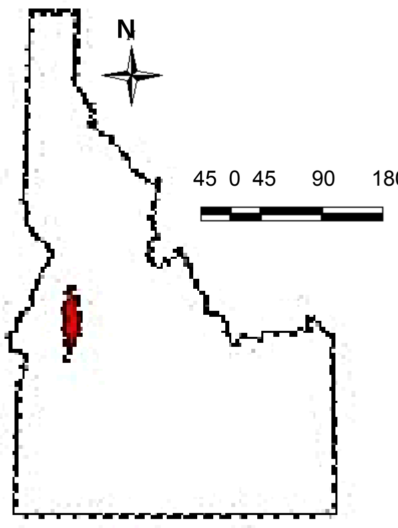
TP	total phosphorus
TS	total solids
TSS	total suspended solids
t/y	tons per year
U.S.	United States
U.S.C.	United States Code
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service
USGS	United States Geological Survey
WAG	Watershed Advisory Group
WBAG	Waterbody Assessment Guidance
WBID	waterbody identification number
WLA	wasteload allocation
WQLS	water quality limited segment
WQMP plan	water quality management
WQS	water quality standard

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., waterbodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the waterbodies in the Cascade Reservoir Watershed that have been placed on what is known as the "§303(d) list."

The phased TMDL analysis for Cascade Reservoir Watershed has been developed to comply with Idaho's TMDL schedule. This and the preceding plans describe the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Cascade Reservoir Watershed located in west central Idaho. The starting point for the phased TMDL process was Idaho's §303(d) list of water quality limited waterbodies. Eight stream segments in the Cascade Reservoir Watershed were listed on Idaho's 1998 §303(d) list. Phase I and Phase II of the Cascade Reservoir Watershed Water Quality Management Plan examined the status of §303(d) listed waters, and defined the extent of impairment and causes of water quality limitation throughout the subbasin. The loading analysis incorporated in Phase I and II quantified pollutant sources and allocated responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards. This (Phase III) document further refines and updates these loads, TMDL implementation progress and the associated water quality trends, and projects future water quality conditions dependant on implementation progress.

Subbasin at a Glance



Cascade Reservoir Watershed

HUC#:	17050123
WQLS#s:	2825, 2829, 2830, 2828, 2831
Major Streams:	North Fork Payette River, Mud Creek, Lake Fork Creek, Boulder Creek, Willow Creek, Gold Fork River, Poison Creek
Pollution Sources:	Point Sources (McCall WWTP and IDFG Fish Hatchery) Nonpoint sources
Eco-Regions:	Blue Mountains – Northern Rockies
Size:	357,000 acres total, 300,980 acres with direct drainage to the reservoir

Figure A. Locator map for the Cascade Reservoir Watershed

The Cascade Reservoir Watershed, hydrologic unit code (HUC) 17050123, encompasses the North Fork Payette River Subbasin from the headwaters to Cascade Dam. This subbasin, incorporating 357,000 acres total, 300,980 acres of which drain directly to Cascade Reservoir, is located in west central Idaho.

Within the Cascade Reservoir Watershed, there are eight water quality limited segments, all of which were identified on the Idaho 1998 §303(d) list. Water quality limited segments addressed by the phased TMDL process include North Fork Payette River (Cascade Reservoir), Gold Fork River, Lake Fork Creek, Mud Creek, Boulder Creek, Willow Creek, Duck Creek, and VanWyck Creek. Figure B shows the subwatersheds in which these streams are located within the Cascade Reservoir Watershed (Duck Creek and Van Wyck Creek are located in the West Mountain Subwatershed). Table A details each listed segment and identifies the pollutant for which the 1998 §303(d) listing was made.

The State of Idaho has designated the following beneficial uses for specified water bodies within the Cascade Reservoir Watershed:

- NORTH FORK PAYETTE RIVER (source to McCall), LAKE FORK CREEK (source to mouth), GOLD FORK RIVER (source to mouth): Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning, primary and secondary contact recreation and special resource water.

Cascade Reservoir Watershed
Total Maximum Daily Load

Watershed, subwatersheds and associated streams

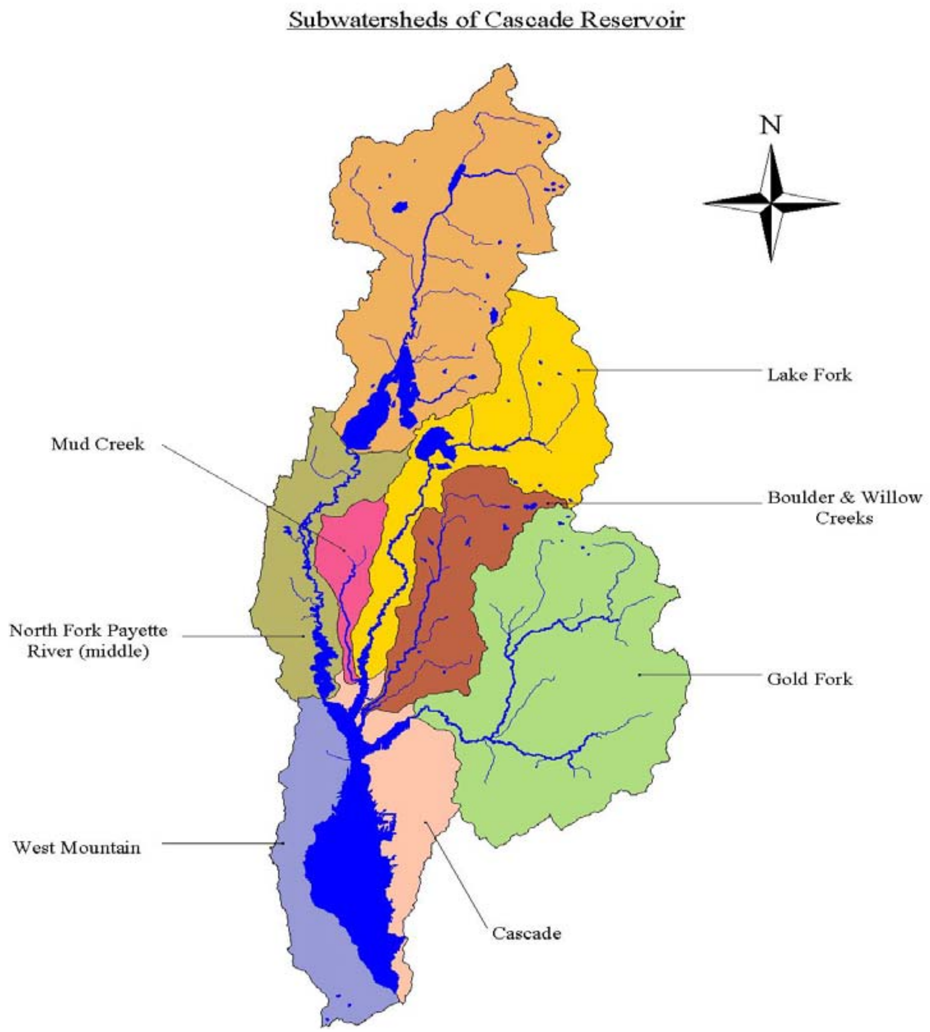


Figure B. Location of the Cascade Reservoir Watershed and associated tributary streams.

Table A. Water Quality Limited Segment Number (WQLS#), AU/WBID# = Assessment Unit/Water Body Identification Number (AU/WBID#), 303(d) Listed Pollutants of Concern and Beneficial Uses for Cascade Reservoir Watershed.

Segment	WQLS #	AU/WBID#	Idaho §303(d) Listed Pollutants	Beneficial Uses
Cascade Reservoir	2884	1705012300 0969	Dissolved Oxygen, Nutrients, pH	Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation
Gold Fork River	2893	ID17050123 SW008 & ID1705SW0 07 (wetland area near Hwy)	Nutrients, Sediment	Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation, special resource water
Boulder Creek	2895	ID17050123 SW011	Dissolved Oxygen, Flow Alteration, Nutrients, Sediment, Temperature	*Undesignated segment*: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics
Mud Creek	2898	ID17050123 SW015	Bacteria, Dissolved Oxygen, Ammonia, Nutrients, Sediment	*Undesignated segment*: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics
Lake Fork	5628	ID17050123 SW012 (below LPL), ID17050123 SW014 (above LPL)	Unknown	Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation, special resource water
Willow Creek	5629	ID17050123 SW011	Unknown	*Undesignated segment*: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics
Duck Creek	5631	ID17050123 SW007	Unknown	*Undesignated segment*: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics
VanWyck Creek	5632	ID17050123 SW007	Unknown	*Undesignated segment*: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics

- NORTH FORK PAYETTE RIVER - McCall to Cascade Dam (includes the reservoir): Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning and primary and secondary contact recreation.

All other listed water bodies within the watershed are unclassified, thus, they are protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish and wildlife, wherever attainable. As noted, state water-quality standards require that all existing uses be fully protected.

In accordance with the Beneficial Use Reconnaissance Program's (BURP) multi-index scoring including the stream macroinvertebrate index (SMI), the stream fish index (SFI) and the stream habitat index (SHI), was used to evaluate the support status of cold water aquatic life for listed stream segments. BURP data were collected in 1994, 1995 and 2002 therefore, the status at the time of assessment may not reflect the current status.

This document contains a summary of the subbasin assessment and pollutant specific TMDLs that were completed in Phase I and II of this TMDL for nutrients. A watershed wide approach was utilized on all TMDLs written. Due to the inter-related nature of the pollutants for which Cascade Reservoir and many of the tributary streams were listed, it is projected that best management practices (BMPs) and other related water quality measures implemented to attain water quality targets within the reservoir will also act to improve water quality in the tributary streams to the extent that water quality standards and designated use support will be attained in all listed segments of the watershed.

At the time of the Phase I and Phase II TMDLs, there were two point sources of pollution to Cascade Reservoir, the McCall wastewater treatment plant (WWTP) and the IDFG fish hatchery in McCall. Both sources discharged directly to NFPR upstream of Cascade Reservoir under NPDES permits. Major pollutants of concern associated with the WWTP discharge are nutrients, predominantly phosphorus. Effluent concentrations vary seasonally and typically exceed ambient concentrations in NFPR. Since 1988, annual total phosphorus discharge from the WWTP loading has remained relatively stable, ranging from 3815 kg to 4751 kg annually. In 2001 the WWTP completed a project to remove (100%) its effluent from NFPR. Since that time there has been no consistent discharge from this facility to NFPR.

Major pollutants of concern associated with the hatchery discharge are nutrients, again, predominantly phosphorus. In 1994 the fish food being used (1.7% phosphorus by weight) was replaced by a food type with lower phosphorus content (0.7% phosphorus by weight). This substitution was further augmented by changes in feeding practices. The combination of these changes has resulted in a substantially reduced phosphorus load since 1994. Pre-1994 total phosphorus loads were evaluated at 726 kg/yr (average). Post-1994 loads have been evaluated at 218 kg (average) total phosphorus annually.

The WWTP for the City of Cascade lies outside of the watershed for Cascade Reservoir. The City of Donnelly uses land application to dispose of treated effluent.

The goals of this and the preceding phases of the Cascade Reservoir Watershed TMDL are to achieve state of Idaho water quality standards for nutrients and sediment in the reservoir and listed stream segments, to minimize impacts on water quality in downstream waters and to restore and maintain a healthy and balanced biological community for the full support of designated and presumed beneficial uses. The load allocations and targets consist of load reductions for nutrients (specifically total phosphorus).

Table B (1 and 2) identifies the key indicators of impairment, the pollutant sources and the target concentrations identified to meet water quality standards in the watershed. Loading analyses were performed where adequate tributary water quality data were available. In order to attain/protect water quality within the watershed, numeric nutrient and chlorophyll *a* targets were identified and load reductions to meet these targets were applied. It is assumed that the attainment of these targets will result in support of beneficial uses within both the reservoir and tributary segments and will contribute to attainment of beneficial use support in the Cascade Reservoir Watershed. Table C lists the segments and the pollutants for which TMDLs were developed.

Table B-1. Target Concentrations for Cascade Reservoir Watershed § 303 (d) Listed Streams
Pollutant Target Concentrations
Dissolved Oxygen: Greater than 6.0 mg dissolved oxygen/L; except in hypolimnion of stratified lakes and reservoirs and the bottom 7 meters in lakes and reservoirs with greater than 35 m depth (IDAPA 58.01.02. 250.02.a)
Nutrients: Surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses. No greater than 0.025 mg/L total phosphorus in-reservoir water column concentration (IDAPA 58.01.02.200.06 [narrative] and target established by the Phase I and II TMDL [numeric] DEQ, 1996 and 1998). Chlorophyll *a* in-reservoir water column concentration no greater than 10 ug/L (target established by the Phase I and II TMDL [numeric] DEQ, 1996 and 1998)
pH: No less than 6.5 and no greater than 9.0 standard units (IDAPA 58.01.02. 250.01.a)

Due to the findings from the Phase I and II TMDLs (DEQ, 1996 and 1998), total phosphorus has been defined as the nutrient of concern for the reservoir. The effects of nitrogen concentrations were also assessed. However, due to the predominance of blue green algae (cyanobacteria) species in observed nuisance algae growth, total phosphorus was determined to be the limiting agent. (Blue-green algae species can fix nitrogen from the air-water interface, therefore reductions in nitrogen loading in the water column would not necessarily result in reduced algae growth.)

Table B-2. Pollutant Sources for Cascade Reservoir Watershed § 303 (d) Listed Streams		
Waterbody	**Key Indicators of Impairment***	**Pollutant Sources**
Cascade Reservoir	Elevated nutrient concentrations Poor or declining shoreline stability Poor or declining riparian vegetation Elevated nutrient concentrations	Agricultural activity/domestic livestock grazing Recreational development/use Roads Natural sources
Gold Fork River	Elevated bacteria concentrations Elevated nutrient concentrations Poor or declining channel stability Poor or declining riparian vegetation Elevated nutrient concentrations **BURP data**	Agricultural activity/domestic livestock grazing Recreational development/use Roads Natural sources
Boulder Creek	Elevated bacteria concentrations Elevated nutrient concentrations Poor or declining channel stability Poor or declining riparian vegetation Elevated nutrient concentrations	Agricultural activity/domestic livestock grazing Recreational development/use Roads Natural sources
Mud Creek	Elevated bacteria concentrations Elevated sediment concentrations Poor or declining channel stability Poor or declining riparian vegetation Elevated nutrient concentrations **BURP data**	Agricultural activity/domestic livestock grazing Recreational development/use Roads Natural sources
Lake Fork	Elevated bacteria concentrations Poor or declining channel stability Poor or declining riparian vegetation Elevated nutrient concentrations **BURP data**	Agricultural activity/domestic livestock grazing Recreational development/use Roads Natural sources
Willow Creek	Elevated bacteria concentrations Elevated sediment concentrations Poor or declining channel stability Poor or declining riparian vegetation Elevated nutrient concentrations **BURP data**	Agricultural activity/domestic livestock grazing Recreational development/use Roads Natural sources
Duck Creek	Poor or declining channel stability Poor or declining riparian vegetation **BURP data**	Domestic livestock grazing Recreational development/use Roads Natural sources
VanWyck Creek	Poor or declining channel stability Poor or declining riparian vegetation **BURP data**	Domestic livestock grazing Recreational development/use Roads Natural sources

* BURP is the beneficial use reconnaissance program.

Table C. Streams and Pollutants for which TMDLs[1] were Developed or Identified as Necessary

Stream	Pollutant(s)
Cascade Reservoir	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
North Fork Payette River	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
Gold Fork River [2]	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
Boulder Creek [2, 3, 4]	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
Mud Creek [2, 5, 6]	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
Lake Fork	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
Willow Creek	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
Duck Creek	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH
Van Wyck Creek	Watershed-wide TMDLs for Dissolved Oxygen, Nutrients, pH

[1] Total Maximum Daily Loads

[2] Segment is listed for sediment. TMDL for nutrient reduction is expected to result in reductions of sediment concentration through improvements in grazing, irrigation and other land management, and stream bank stabilization and revegetation projects.

[3] Although flow alteration can adversely affect beneficial uses, there are no Idaho water quality standards or criteria that address it. Flow alteration is not suitable for estimation of load capacity or load allocation and it is the policy of DEQ that TMDLs will not be written to address it. Therefore, although Boulder Creek is listed for flow alteration, a TMDL for flow alteration will not be written at this time.

[4] Segment is listed for temperature. TMDL for nutrient reduction is expected to result in increased shade and instream flow through improvements in grazing, irrigation and other land management, and stream bank/riparian revegetation projects.

[5] Segment is listed for bacteria. TMDL for nutrient reduction is expected to result in reductions of bacteria loading through improvements in grazing, irrigation and other land management, and stream bank/riparian revegetation projects.

[6] Segment is listed for ammonia. TMDL for nutrient reduction is expected to result in reductions of ammonia concentration through improvements in grazing, irrigation and other land management, and related water-quality improvement projects.

Key Findings

The findings of the Phase I and II TMDLs for Cascade Reservoir Watershed clearly indicate that fishing, swimming, boating and agricultural water supply are not fully supported in Cascade Reservoir. Additional impairments to beneficial uses (designated or presumed) are listed in Table D. The majority of negative effects in the tributary streams were observed to occur near their inflow to the reservoir.

Table D. Beneficial Uses Affected

Stream	Use
Cascade Reservoir	Domestic water supply, agricultural water supply, cold water aquatic life, primary contact recreation, secondary contact recreation
North Fork Payette River	Downstream water quality, agricultural water supply, primary contact recreation, secondary contact recreation
Gold Fork River	Downstream water quality, agricultural water supply, primary contact recreation, secondary contact recreation
Boulder Creek	Downstream water quality, agricultural water supply, primary contact recreation, secondary contact recreation
Mud Creek	Downstream water quality, agricultural water supply, primary contact recreation, secondary contact recreation
Lake Fork	Downstream water quality, agricultural water supply, primary contact recreation, secondary contact recreation
Willow Creek	Downstream water quality, agricultural water supply, primary contact recreation, secondary contact recreation
Duck Creek	Aesthetics
VanWyck Creek	Aesthetics

Implementation within the watershed was initiated with the Phase I TMDL process and is yielding water quality improvements. Mean summertime total phosphorus and chlorophyll *a* concentrations in the reservoir show a decreasing concentration trend since implementation of the Phase I TMDL started in 1994. An increasing trend in water clarity is also evident, indicating less suspended sediment and less algae growth in the reservoir. Excessive algae growth has also been observed to occur over less of the reservoir surface.

With the completion of the J-Ditch project, estimated point source reductions from this project equal 3,947 kg/year. Combined with the reductions accomplished by the IDFG Fish Hatchery, 100% of the total point source reduction goal has been accomplished.

Measured and estimated nonpoint source reductions (including reductions from septic to sewer upgrades) equal 4,593 kg/year (~41% of the nonpoint source goal). With the completion of implementation projects to date, forestry nonpoint sources achieved 100% of their reduction goal for total phosphorus.

Due to changes in land use occurring within the watershed, some adjustments to the load allocations identified in the Phase II TMDL are necessary. Total reductions required in phosphorus loading from agricultural lands use have been decreased by 79 kg/year. Total reductions required in phosphorus loading from agricultural lands use have been increased by 567 kg/year. These changes are well within the established margin of safety (7%) for the assigned load allocations and therefore do not represent a concern for attainment of water quality targets within the watershed.

Given the available data, no changes to the 2003 § 303 (d) list are proposed at this time.

Public Process

Throughout this phased TMDL process, local experience and participation have been and will continue to be invaluable in the identification of water quality issues and reduction strategies appropriate on a local scale. The public committees created for the Cascade Reservoir Watershed, known as the Cascade Reservoir Coordinating Council (CRCC) which functions as the Watershed Advisory Group (WAG) for Cascade Reservoir Watershed; and the Cascade Reservoir Technical Advisory Committee (TAC), have been involved in the review and assessment of all phased TMDL documents.

The CRCC and TAC provide an opportunity for concerned citizens, representing a number of stakeholder interest groups, to see the TMDL process through from start to finish. Additionally, members represent a critical mechanism in disseminating information to their respective interest groups and relaying concerns and advice from these interest groups to the Idaho Department of Environmental Quality. Interested citizens not involved directly through these groups can get involved in the TMDL process through attending public comment and informational meetings as well as CRCC and TAC meetings.

A more detailed discussion of the overall public process associated with this phased TMDL is available in the Phase I and II documents (DEQ 1996 and 1998).

Reasonable Assurance

The state of Idaho uses a voluntary approach to control agricultural nonpoint sources. However, regulatory authority can be found in the state water quality standards (IDAPA 58.01.02350.01 through 58.01.02350.03). IDAPA 58.01.02054.07 refers to the Idaho Agricultural Pollution Abatement Plan (IAPAP), which provides direction to the agricultural community for approved BMPs.

For nonpoint sources, a feedback loop has been and will continue to be used to achieve water quality goals. If monitoring indicates a violation of standards despite use of approved BMPs or knowledgeable and reasonable efforts, then BMPs for the nonpoint source activity must be modified by the appropriate agency to ensure protection of beneficial uses (Idaho Water Quality Standards and Wastewater Treatment Requirements, IDAPA 58.01.350.02.b.ii).

To date, this voluntary approach has proven to be effective in achieving widespread participation and implementation of BMPs in all nonpoint source classifications. It is expected that this same approach will be effective in the future as the local agricultural/ranching and other nonpoint source community has demonstrated a willingness to implement BMPs and protect water quality. In the event that BMPs for nonpoint sources are not implemented adequately using a voluntary approach, the Idaho Department of Environmental Quality will use existing regulatory authorities to seek water quality improvements.

The load reductions for these watersheds rely on nonpoint source reductions to achieve desired water quality and to restore beneficial uses. To ensure that these nonpoint source mechanisms are operating effectively and to calculate reduction efficiency, monitoring will be conducted.

Implementation Considerations

It is recognized that the TMDL addresses a complex system that includes a combination of diverse natural and nonpoint pollutant sources. Limited data are available to this TMDL effort for the evaluation of water quality violations and beneficial use support status. This TMDL has therefore adopted a phased approach to implementation that has identified interim, measurable milestones for determining whether management measures or other action controls are being implemented and a process for implementing stronger and more effective management measures if necessary. It is expected that information will continue to be collected to fill existing data gaps and allow a more accurate determination of the status of beneficial uses within the watershed and the impact of pollutants delivered to and processed by the system.

1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., waterbodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the waterbodies in the Cascade Reservoir Watershed that have been placed on what is known as the "§303(d) list."

This document, together with the Phase I and Phase II Watershed Management Plans (TMDLs) prepared for the Cascade Reservoir Watershed, is part of an ongoing process for improvement of water quality in the reservoir and its tributaries. The Phase I management plan identified in-reservoir water-quality standards for reduction of algal growth, point and nonpoint sources of nutrient loading, subwatershed specific load allocations and reductions required to meet the in-reservoir water-quality standards. The Phase II management plan further refined point and nonpoint sources of nutrient loading, subwatershed-specific load allocations and load reductions required. The Phase III management plan assesses progress achieved to date, updates the previous plans with current information and projects water quality improvements for the future if recommendations are met. All three management plans have been developed by the Idaho Department of Environmental Quality (DEQ), Cascade Satellite Office and Boise Regional Office, and are consistent with Idaho Code 39-3611, which details the "Development and Implementation of Total Maximum Daily Loads or Equivalent Processes". The overall goal of these plans is to restore and maintain water quality in Cascade Reservoir and its tributaries to a level that meets state water quality standards and protects designated beneficial uses.

As stated in the Phase I management plan: "It is important to note that correction of water-quality problems in Cascade Reservoir will not happen overnight. Successful implementation of this plan requires a coordinated effort of planning and best management practice implementation involving concerned government agencies and land owners in the watershed over the next several years."

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the waterbodies to meet their designated uses. These requirements result in a list of impaired waters, called the "§303(d) list." This list describes waterbodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and TMDL provide a summary of the water quality status and allowable TMDL for waterbodies on the §303(d) list. The *Cascade Reservoir Watershed Phase I, II and III Water Quality Management Plan* provides this summary for the currently listed waters in the Cascade Reservoir Watershed.

The Cascade Reservoir Watershed Phase I and II TMDLs contain an indepth evaluation and summary of the current water quality status, pollutant sources, and control actions in the Cascade Reservoir Watershed to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a waterbody and still allow that waterbody to meet water quality standards (Water quality planning and management, 40 CFR 130). Consequently, a TMDL is waterbody- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." TMDLs are not required for waterbodies impaired by pollution, but not specific pollutants. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several waterbodies and/or pollutants within a given watershed.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a waterbody by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho waterbodies to support. These beneficial uses are identified in the Idaho water quality standards and include:

- Aquatic life support – cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation – primary (swimming), secondary (boating)
- Water supply – domestic, agricultural, industrial
- Wildlife habitats, aesthetics

The Idaho legislature designates uses for waterbodies. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses for all waterbodies in the state. If a waterbody is unclassified, then cold water and primary contact recreation are used as additional default designated uses when waterbodies are assessed.

A subbasin assessment entails analyzing and integrating multiple types of waterbody data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the waterbody (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the waterbody, particularly the identity and location of pollutant sources.
- When waterbodies are not attaining water quality standards, determine the causes and extent of the impairment.

1.2 Physical and Biological Characteristics

Cascade Reservoir is located in the Payette River Basin of west central Idaho (Figure 1.1). The headwaters originate in Upper Payette Lake, which drains into Big Payette Lake, the outflow of which is the North Fork Payette River (NFPR). The NFPR flows in a southerly direction for approximately 30 miles before emptying into Cascade Reservoir. Below the reservoir, NFPR discharges into the Main Payette River near Banks, Idaho, 35 miles downstream. Major tributaries to the reservoir include NFPR, Mud Creek, Lake Fork, Boulder Creek, Gold Fork

Figure 1.1. Location of the Cascade Reservoir Watershed (HUC17050123)

River and Willow Creek, all of which discharge into the northern end of the reservoir. The overall watershed is divided into separate subwatersheds on the basis of drainage areas to these tributaries. As listed in the Phase II TMDL, there are twelve subwatersheds within the Cascade Reservoir Watershed, eight of which drain more or less directly into Cascade Reservoir. The latter are addressed in this plan and include NFPR, Mud Creek, Lake Fork, Boulder Creek, Willow Creek, Gold Fork River, Cascade and West Mountain (Figure 1.2). Additional information on how subwatershed boundaries were determined is available in the Phase II TMDL (DEQ, 1998).

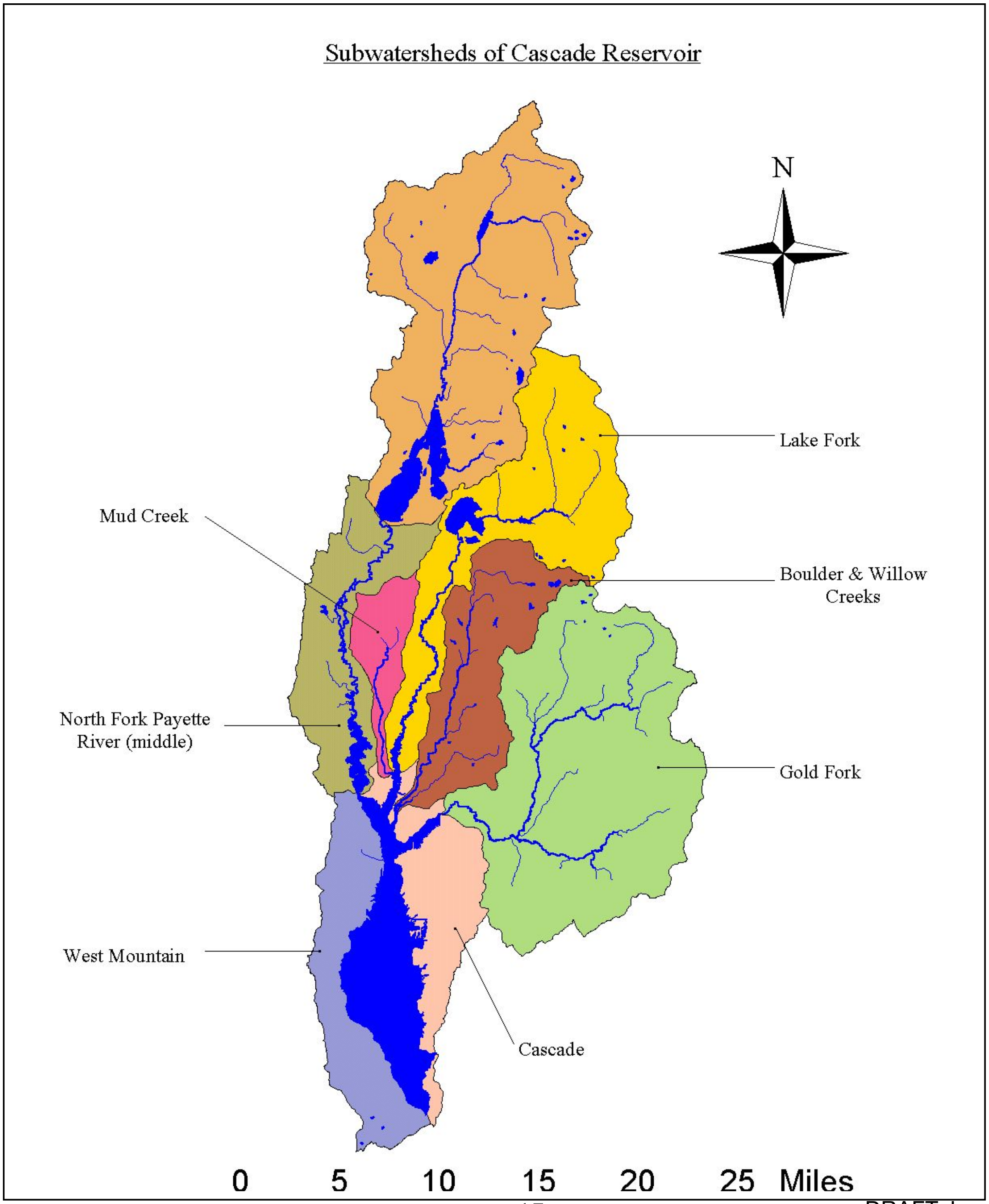
The Cascade Reservoir Watershed (part of HUC 17050123) encompasses approximately 357,000 acres located in a moderately high elevation valley between West Mountain and the Salmon River Mountains. Direct drainage area to Cascade Reservoir included in this watershed management plan covers approximately 300,980 acres. A major portion of the watershed is steeply-sloped forested land, while the area immediately adjacent to the reservoir and major tributaries is predominantly shallow-sloped agricultural land. Elevation of the valley floor and reservoir is approximately 4,850 feet. Only minor changes in local relief occur on the valley floor, while elevation increases sharply once into the forested lands. The highest point in the watershed is 8,322 feet elevation at Snowbank Mountain, southwest of the reservoir (BOR, 1991).

Cascade Reservoir was created in the spring of 1949 with the completion of Cascade Dam, an earthen structure 107 feet high and 785 feet long, which was constructed across NFPR, north-northwest of the present day location of the City of Cascade. Congress authorized construction of the reservoir to provide storage for irrigation and power generation at Black Canyon Dam on the main stem Payette River near Emmett, Idaho. Full storage was reached in 1957. The reservoir is 21 miles long, 4.5 miles wide at the widest point and is relatively shallow, measuring 26.5 feet in average depth.

Climate

Seasonal temperatures show a winter average of 19 ^{o}F (January) and a summer average of 79 ^{o}F (July) based on data collected from 1971 through 2000 (WRCC, 2003). Temperatures extremes within the watershed range from -40 ^{o}F to 100 ^{o}F. Mean annual precipitation is 22 inches, roughly 65% of which falls in the winter (October through March) as snow (WRCC, 2003). Mean annual snowfall is 95 inches, with two to four feet on the ground throughout the winter season. The reservoir freezes over completely during the winter months. Full ice cover is usually in place by December and lasts until April. Spring weather is commonly cool and wet. Summers are generally warm and dry. Summer thunderstorms are common, but do not represent a primary precipitation source.

Figure 1.2. Location of the subwatershed boundaries within the Cascade Reservoir Watershed.



Subbasin Characteristics

Hydrology

Hydrology of the Cascade Reservoir Watershed is composed of a variety of natural and anthropogenic (human-induced) features. Natural features include streams, lakes, springs and wetlands. Anthropogenic features such as ponds, irrigation ditches and diversions dominate the flow of water within the watershed. Predominant stream-flow within the watershed is north to south along the length of the valley. Smaller streams (primarily along the west side of the reservoir) flow from the ridge-lines into the reservoir. The significant number of irrigation diversions and drainage canals within the watershed complicate the identification of flow and transport patterns.

Surface Hydrology.

Cascade Reservoir is operated by the U.S. Bureau of Reclamation (BOR) in correlation with two other reservoirs (Deadwood and Black Canyon) to meet irrigation, hydropower, flood control, recreation and wildlife habitat needs. Maximum storage capacity is approximately 693,000 acre-feet. A 50,000 acre-foot minimum pool has been congressionally authorized, and although the BOR has the authority to lower the reservoir to this level, an administrative decision was made by the BOR in 1984 that a 300,000 acre-foot minimum pool would be maintained. Average annual drawdown (1984 to present) is 12 feet. Natural flows (~200 cfs) from the outlet of Cascade Reservoir are maintained during the winter months for power production at Black Canyon Dam. Storage for summer irrigation needs is initiated in the fall of the year and peaks in the early summer. Annual low water levels occur in October, high water levels occur in June. Water is released downstream to serve irrigators directly or to augment storage for Black Canyon Reservoir, where it can be further diverted or released as necessary. Irrigation releases usually start in May/June and end in November. When necessary, the level of Cascade Reservoir may be dropped preceding spring thaw as a flood control measure for downstream areas.

Stream flow within the watershed is characterized by three major events, snow-melt, rain-on-snow and seasonal thunderstorms. Snow-melt runoff is the predominant flow used to fill the reservoir. Natural stream and irrigation channels convey snow-melt runoff to the reservoir and other water bodies in two major events, valley melt (usually occurring in March and April) and mountain snow-melt (usually occurring in June and July). During the irrigation season (June thru October), a significant portion of the total tributary flow is diverted for irrigation of pasture land and fields. The predominant irrigation practice within the watershed is sub-flood irrigation although the utilization of sprinkler irrigation systems is increasing in many areas.

Ground-Water Hydrology.

Ground water within the Cascade Reservoir Watershed can be divided into two major categories: natural ground water and irrigation recharge. Natural ground water refers to ground water that is present due to geological and natural hydrological processes. It occurs at a variety of subsurface levels, but is predominantly located 35 to 400+ feet below the ground surface. Irrigation recharge refers to sub-surface water present due to local irrigation practices trapped between the soil surface and one of several existing clay layers known as hard-pan or clay-pan. These perched layers commonly occur at depths from 2 to 10 feet below the surface. Ground-water contributions to Cascade Reservoir have been estimated at <5% of the total reservoir volume (USGS, 1998).

Geology

The Cascade Reservoir Watershed lies within the Idaho Batholith, a formation of crystalline igneous rock of volcanic origin. The Payette River Basin is located entirely within this formation, which covers approximately 20,000 square miles in north and central Idaho. Local lithology is predominantly granite (granite gneiss, mica schist and porphyritic biotite-granite) with some smaller amount of basalt. Major rock outcroppings are highly weathered, decomposing material that is unstable, highly transportable and easily eroded. Soils are primarily coarse textured. Predominant soil types within the valley are Archbal, a deep well-drained strongly acid loam formed in alluvium or glacial outwash occurring in 12 % of the watershed, 30 % of the agricultural land; Donnel, a deep well-drained medium acid sandy-loam soil formed in granitic alluvium and occurring in 5 % of the watershed, 20 % of the agricultural land; and Roseberry, a deep poorly-drained medium acid sandy-loam formed in alluvium or glacial outwash of granitic origin occurring in 7 % of the watershed, 20 % of the agricultural land (Rasmussen, 1981). Soil depths within the watershed are highly variable, ranging from 30 to 40 inches for Donnel and Roseberry soils and from 5 to 8 feet for Archbal soil types over the valley.

There are two major erosive processes within the Cascade Reservoir Subwatershed: surface erosion (commonly the result of precipitation events) and mass wasting which includes landslides, earthflows or slumps, and debris torrents. Both types of erosion can be naturally induced, for example, the soil displaced by an avalanche; or management induced, as in the transport of material from an unstabilized cut-slope on a roadway. Within the Cascade Reservoir Watershed approximately 213 mass-wasting events have been identified as occurring within the last 30 years. Of these, 40 occurred in the West Mountain Subwatershed and the remaining 173 occurred in the Gold Fork Subwatershed where steep slopes combine with unstable lithology. Roughly 96% (204) of the mass wasting events identified were the result of natural processes and nine (4%) were the result of management activities, predominantly roads (BCC, 199; USFS, 1998).

The watershed is transitional ecologically with the western half of the valley found within the Blue Mountains ecoregion (Omernik and Gallant, 1986), which is characterized by mountain ranges separated by fault valleys and synclinal basins. The eastern and northern sections of the watershed are found within the Northern Rockies ecoregion with geology and soils typical of the northern portion of the Rocky Mountains.

Flora, Fauna and Fisheries

Vegetative communities present within the Cascade Reservoir Watershed are *forestland*, containing a variety of spruce and fir species; *grassland-riparian*, containing shrub, grass and sedge species (both natural and introduced); and *nonriparian*, containing mixed conifers of various types.

Predominant vegetation on the valley floor is introduced species for animal forage, cultivated for both hay and grazing. These species include bromes, timothy, fescue, clover and alfalfa. Native species in non-irrigated areas of the valley floor include bluebunch wheatgrass, Idaho fescue, lupine, elk sedge, arrowleaf balsamroot and mountain big sagebrush. Riparian vegetation includes sedges, rushes and willows. Mountainous areas are predominantly forested, with major species including Ponderosa pine, Douglas fir and Grand fir. Understory species include pine reedgrass, western thimbleberry, beargrass, elk sedge, Woods rose and snowberry (USFS, 1998; Rasmussen, 1981).

The Cascade Reservoir Watershed supports many natural and stocked fisheries. Fish species present include yellow perch; rainbow, brown, brook and bull trout; coho and kokanee salmon; mountain whitefish; brown bullhead, westslope cutthroat, large-scale sucker, sculpin, dace and northern squawfish. The Idaho Department of Fish and Game (IDFG) stocks the reservoir regularly with coho and kokanee salmon, rainbow and brown trout, small-mouth bass, splake, channel catfish, and tiger muskie. Wildlife populations within the watershed include elk, deer, fox, bear, beaver, cougar, otter, mink, badger, skunk, racoon, porcupine, weasel, coyote and moose. The watershed also supports both migrating and year-round water- and wild-fowl and a diverse population of raptors. Avian species include heron, geese, grebes, eagles, loons, pelicans, swans, forest grouse, ducks, osprey, owls, quail, cranes and a variety of shore and songbirds. Grebe and heron rookeries exist along the western edge and northern arms of the reservoir. A brown bat nursery has been identified near the inflow of NFPR.

Special Designations.

Special Status Plants are plants that are managed under the USFS Regional Sensitive Species Program. Only one Special Status Plant (Tall Swamp Onion) is documented as present within the watershed (Skein Lake). This plant requires marshes, mud flats, or standing water for survival and propagation. These plants tend to favor mid-range to high elevations and are heavily impacted by grazing and recreational activities (USFS, 1998).

The Cascade Reservoir Watershed is potentially home to three species currently listed under the Endangered Species Act: the grey wolf, the peregrine falcon and the bald eagle. Of the three, the bald eagle is the only regularly documented species present. The grey wolf occurs only occasionally in the watershed area, and the peregrine falcon, while historically documented within the watershed, has not been present for over 20 years.

Several active nesting sites for bald eagles are within the watershed boundaries. Most nesting sites are on the edge of the reservoir, usually within 1.5 km of shore, and occupy USFS, BOR and private land. The eagles use snags, trees with exposed limbs and lateral branches, for perching and nesting. Forage is predominantly fish and small birds. Lack of adequate perch trees, recreational and urban encroachment on nesting and forage territories and poor water quality represent major impacts to bald eagle habitat within the watershed.

1.3 Cultural Characteristics

Land use and population within the Cascade Reservoir Watershed has been changing constantly since before the white settlement of the region. This dynamic nature continues to the present day.

Land Use and Ownership

The watershed is predominantly forested (~67%), with both public (USFS and State of Idaho) and private ownership (Table 1.1). Much of the private land is used for agricultural purposes, predominantly cattle ranching. Only a small amount of private land is used for crops. Urban and residential areas make up roughly 10% of the total land area.

Table 1.1 Land use acreage within the Cascade Reservoir Watershed*.

Drainage Area	Acres	% of Watershed Area
Forest (public and privately owned)	180,737	65.4
Agriculture (irrigated crop and pasture, non-irrigated pasture, rangeland and other)	64,170	23.2
Urban/Suburban (urban/city area, subdivisions, impact area)	31,474	11.4
TOTAL DRAINAGE AREA	276,381	100%

*Figures reflect land use changes through 2002.

Historically, land use in the watershed was primarily forestry/timber and agricultural, with a very small amount of residential property. Land use trends have recently shown a decrease in agricultural land use and an increase in land designated as subdivisions and rural ranchettes.

A more detailed discussion of land use and ownership is available in the Phase II TMDL (DEQ, 1998).

Population

Population centers within the watershed boundaries (McCall, Lake Fork, Donnelly, Roseberry and Cascade) are located in Valley County, primarily along State Highway 55 (Figure 1.1). Total population estimates for Valley County average approximately 7,700 individuals, the majority of which reside in McCall (population ~2,600) and Cascade (population ~1,000), and in the adjacent unincorporated areas. In addition to the local resident population, tourism and recreational opportunities have created a significant transient (non-county resident) population and vacation home development in many areas.

History and Economics

Historically, the economy of the watershed was based almost solely on timber harvest and agriculture. Recently however, with the cutbacks in the timber industry, the balance has shifted toward the service industry, as tourism and recreation in the area have increased. The current economy of the region is increasingly dependent on tourism, especially the cities of McCall and Cascade. Smaller communities within the watershed remain heavily dependent on agriculture and livestock.

Valley County is one of the fastest growing counties in the state of Idaho. The population of Valley County is expected to increase by over 50% by the year 2010. The proximity of Cascade Reservoir to State Highway 55 has contributed to its reputation as a major destination site. Many popular hiking, cycling, cross-country skiing and snowmobile trails are available to residents and tourists, as are numerous opportunities for fishing, hunting, camping, boating and water-skiing.

2. Subbasin Assessment – Water Quality Concerns and Status

Popularity of Cascade Reservoir and tributaries within the watershed as a vacation/recreational destination is dependent upon water quality and (perhaps more importantly) perceived water quality. Historically, Cascade Reservoir ranked first among the fisheries within the state. With the water-quality problems observed in the early 1990's however, it has fallen to number eight. While fish habitat within the reservoir rebounded somewhat in 1996 and 1997, estimated reservoir angler-hours for these years still show a decrease of greater than 50% from the pre-1993 value. This decrease may be due more to the perceived water quality within the reservoir rather than the actual quality of the fishery. This decline, and the accompanying decline in other recreational uses, has had a significant and noticeable impact on the local economy.

2.1 Water Quality Limited Segments Occurring in the Subbasin

Cascade Reservoir has been identified as water quality limited under section 303(d) of the Clean Water Act (CWA). Water quality studies have shown that phosphorus is the pollutant of concern within the watershed. Nuisance algae growth resulting from nutrient loading has impaired the designated beneficial uses of the reservoir, specifically, fishing, swimming, boating and agricultural water supply.

Within the Cascade Reservoir Watershed, there are eight water quality limited segments, all of which were identified on the Idaho 1998 §303(d) list. These include North Fork Payette River, Mud Creek, Lake Fork, Boulder Creek, Gold Fork River, Willow Creek, Kennally Creek, Cascade and West Mountain. Table 2.1 details each listed segment and identifies the pollutant for which the 1998 §303(d) listing was made.

Table 2.1. §303(d) Segments in the Cascade Reservoir Watershed.

Waterbody Name	Segment ID	1998 §303(d)[1] Boundaries	Pollutants
Cascade Reservoir	2884	Inflow of NFPR to dam	Dissolved Oxygen, Nutrients, pH
Gold Fork River	2893	Flat Creek to Cascade Reservoir	Nutrients, Sediment
Boulder Creek	2895	Headwaters to Cascade Reservoir	Dissolved Oxygen, Flow Alteration, Nutrients, Sediment, Temperature

Waterbody Name	Segment ID	1998 §303(d)[1] Boundaries	Pollutants
Mud Creek	2898	Headwaters to Cascade Reservoir	Bacteria, Dissolved Oxygen, Ammonia, Nutrients, Sediment
Lake Fork	5628	Headwaters to Cascade Reservoir	Unknown
Willow Creek	5629	Headwaters to Cascade Reservoir	Unknown
Duck Creek	5631	Headwaters to Cascade Reservoir	Unknown
VanWyck Creek	5632	Headwaters to Cascade Reservoir	Unknown

[1]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection "d" of the Clean Water Act.

2.2 Applicable Water Quality Standards

Water quality standards under the CWA consist of three main components: designated beneficial uses, water quality criteria that are established to protect designated beneficial uses and antidegradation policies and procedures. Water quality criteria can be either numeric limits for individual pollutants and conditions, or narrative descriptions of desired conditions.

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and "presumed" uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (DEQ, 2002) gives a more detailed description of beneficial use identification for use assessment purposes. The designated and presumed uses for the §303(d) listed segments in the Cascade Reservoir Watershed addressed by this phased TMDL process are identified in Tables 2.2 and 2.3.

Table 2.2. Cascade Reservoir Watershed designated beneficial uses.

Waterbody	Designated Uses	1998 §303(d) List[1]
Cascade Reservoir	Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation	✓
Gold Fork River	Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation, special resource water	✓
Lake Fork	Domestic water supply, agricultural water supply, cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation, special resource water	✓

[1]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.

Table 2.3. Cascade Reservoir Watershed existing/presumed beneficial uses.

Waterbody	Existing/Presumed Uses	1998 §303(d) List[1]
Boulder Creek	Undesignated: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics	✓
Mud Creek	Undesignated: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics	✓
Willow Creek	Undesignated: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics	✓
Duck Creek	Undesignated: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics	✓
VanWyck Creek	Undesignated: presumed to support cold water aquatic life and secondary contact recreation *State-wide*: agricultural and industrial water supply, wildlife habitat and aesthetics	✓

[1]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.

Existing Uses

Existing uses under the CWA are "those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.003.35, .050.02, and 051.01 and .053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. Practical application of this concept would be when a water could support salmonid spawning, but salmonid spawning is not yet occurring.

Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each waterbody or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho these include things like aquatic life support, recreation in and on the water, domestic water supply, and agricultural use. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for waterbodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.22 and .100, and IDAPA 58.01.02.109-160 in addition to citations for existing uses.)

Presumed Uses

In Idaho, most waterbodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric criteria cold water and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water is not found to be an existing use, a use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria. (IDAPA 58.01.02.101.01).

2.3 Summary and Analysis of Existing Water Quality Data

The Cascade Reservoir Watershed has been the subject of numerous water quality studies and monitoring efforts, ranging from 1975 to the present.

<u>Flow Characteristics</u>

Figure 2.1 shows a hydrograph of median monthly inflows and outflows for Cascade Reservoir. The inflows of NFPR, Gold Fork River and Lake Fork Creek represent over 90% of the total inflow to Cascade Reservoir. As illustrated in this plot, the vast majority of inflow (volume) is delivered between April and July in an average year. The majority of outflow occurs between May and October. Water elevations within the reservoir are highest between March and September and lowest in the winter and early spring months.

Stream runoff is moderately bi-modal, exhibiting a smaller increase as the snow accumulated in the lower “valley” elevations melts off (commonly in late April), followed by a more pronounced increase in flow volume as larger mountain accumulations melt with the onset of warmer temperatures in late May or June.

Reservoir outflow is more sharply bi-modal in nature, with increased flood-control releases correlated with the mountain snow melt, and summer long irrigation releases to water rights holders in the lower Payette River Basin.

The last five years (1999 through 2003) have been low water (drought) years within the Cascade Reservoir Watershed and much of the State of Idaho, with record setting below average precipitation and warmer air temperatures recorded in 2001.

Water Column Data

Water column data is available for a number of sites in the Cascade Reservoir Watershed since 1975. Routine DEQ monitoring started in 1989 and increased in frequency with the advent of toxic algae growth in 1993. Seven routine monitoring sites have been sampled on a monthly basis since 1993, representing all major tributary inflows to the reservoir. In addition, four in-lake monitoring sites have been sampled at multiple depths from ice-out to ice-in during this same time period. Additional data collection has occurred over the course of TMDL implementation in the form of USFS tributary sites in many of the subwatersheds, and long-term BOR monitoring (in-lake). Monitoring of the efficiency of created wetlands occurred between 1996-2000 as a joint venture between DEQ and BOR. Monitored constituents include water chemistry parameters (nutrients, sediment, chlorophyll a, bacteria and others), field parameters (pH, flow, conductivity, dissolved oxygen, temperature), and biological parameters among others. An in-depth discussion of the available data sources is available in both the Phase I and II TMDLs.

Monthly monitoring indicates that the vast majority of nutrient loading to the reservoir, and the related water quality impacts occur during the summer growing and irrigation season (April through September). Sediment loading is bi-modal, with a major peak at the initiation of spring run-off and a lesser peak observed during the irrigation season. Low dissolved oxygen concentrations observed during late summer are commonly inversely correlated with water

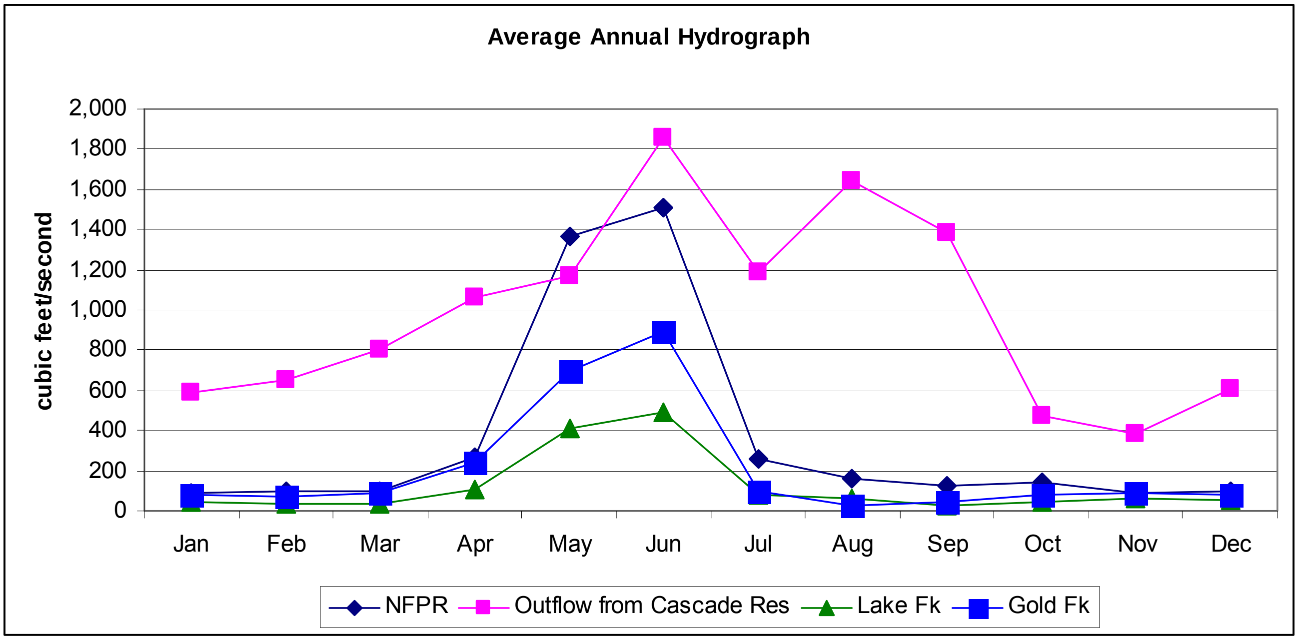


Figure 2.1 Average hydrograph of major inflows and outflow for Cascade Reservoir.

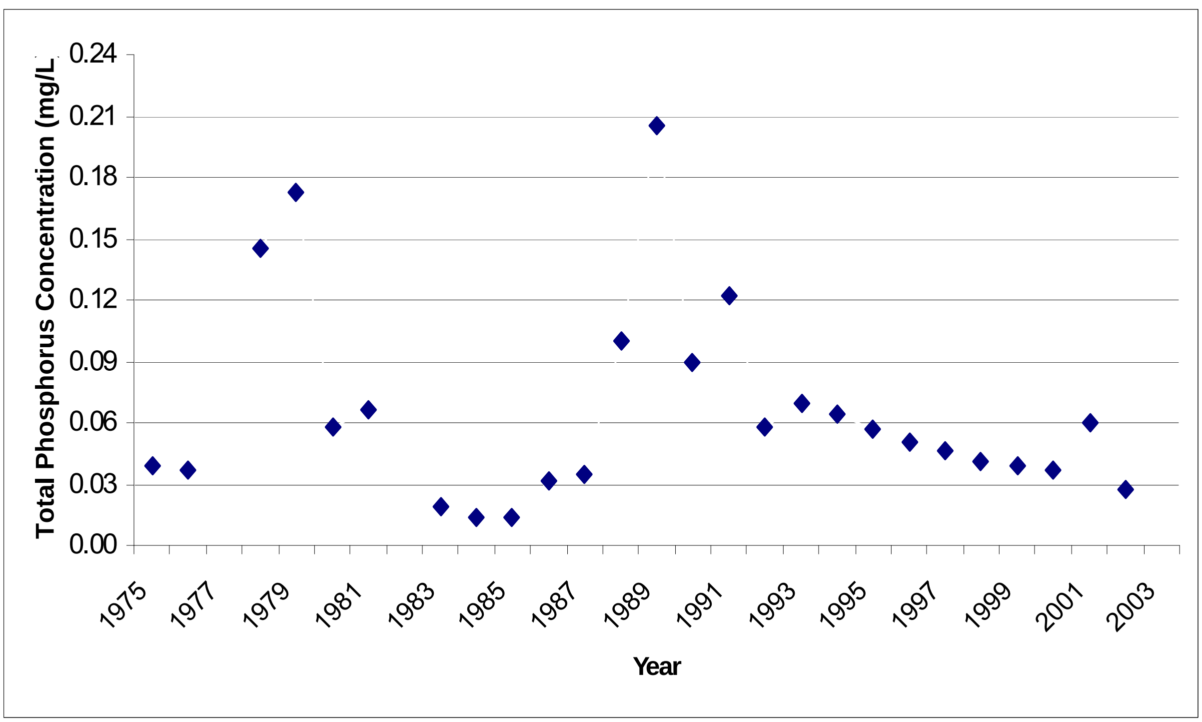


Figure 2.2 Mean summertime total phosphorus concentration in Cascade Reservoir from 1975 through 2003.

column total phosphorus concentrations, due to the anoxic release of adsorbed phosphorus from bottom sediments.

Available data show that through 1995, growing season total phosphorus concentrations in-reservoir were greater than two times the target identified by the phased TMDL process of 0.025 mg/L total phosphorus (Figure 2.2). Similar exceedences in growing season water column chlorophyll a concentrations were observed through 1995, with concentrations at or above the target of less than 10 ug/L of chlorophyll a observed in middle to late summer in many places in the reservoir (Figure 2.3).

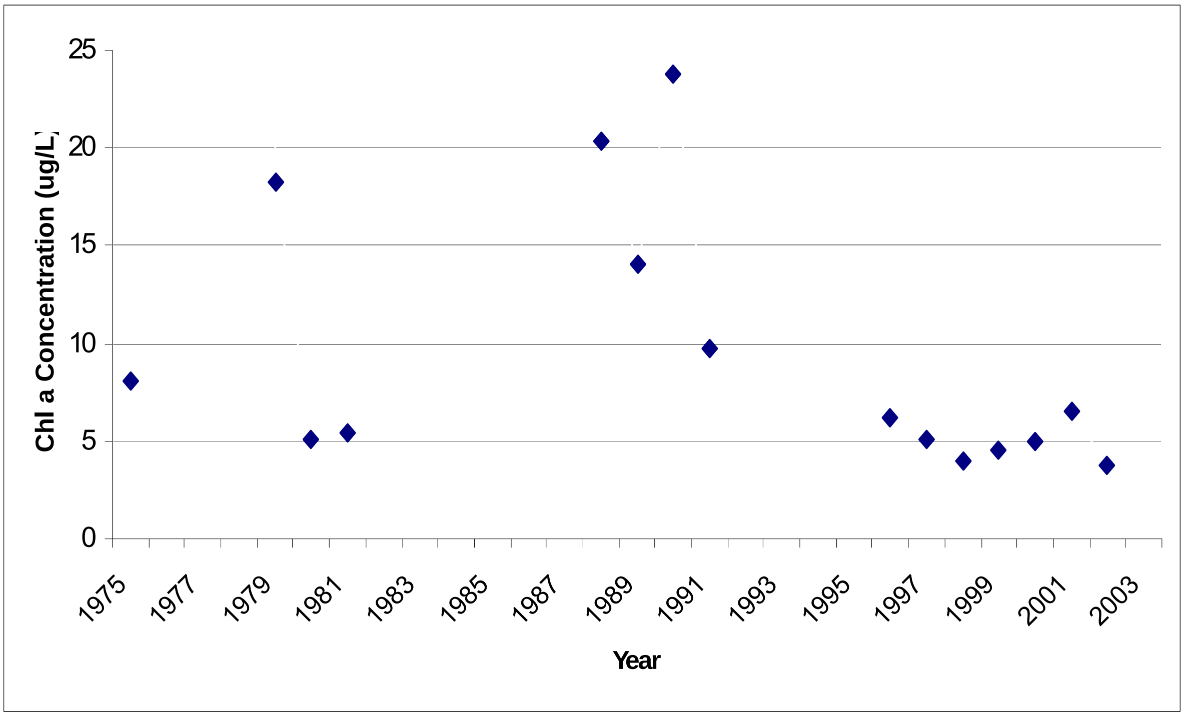


Figure 2.3 Mean summertime chlorophyll *a* concentration in Cascade Reservoir from 1975 through 2003. Note: The scale of this plot does not display very high chlorophyll a concentrations observed in 1978 (119 ug/L) and 1993 (122 ug/L).

Exceedences of the TMDL targets have occurred less frequently since the start of implementation in 1994 as illustrated in Figures 2.2 and 2.3. Median water column total phosphorus concentrations have consistently decreased in all years since 1994 except 2001 (an exceptional drought year). Median water column concentrations are still roughly twice the target value, but represent a decrease of over 50% since implementation began.

Although chlorophyll a data prior to 1993 was highly variable, a marked decreasing trend is also noticeable since the start of implementation in 1994, again with the exception of 2001. A plot of Secchi depths measured over this same time period (Figure 2.4) shows a high degree of variation

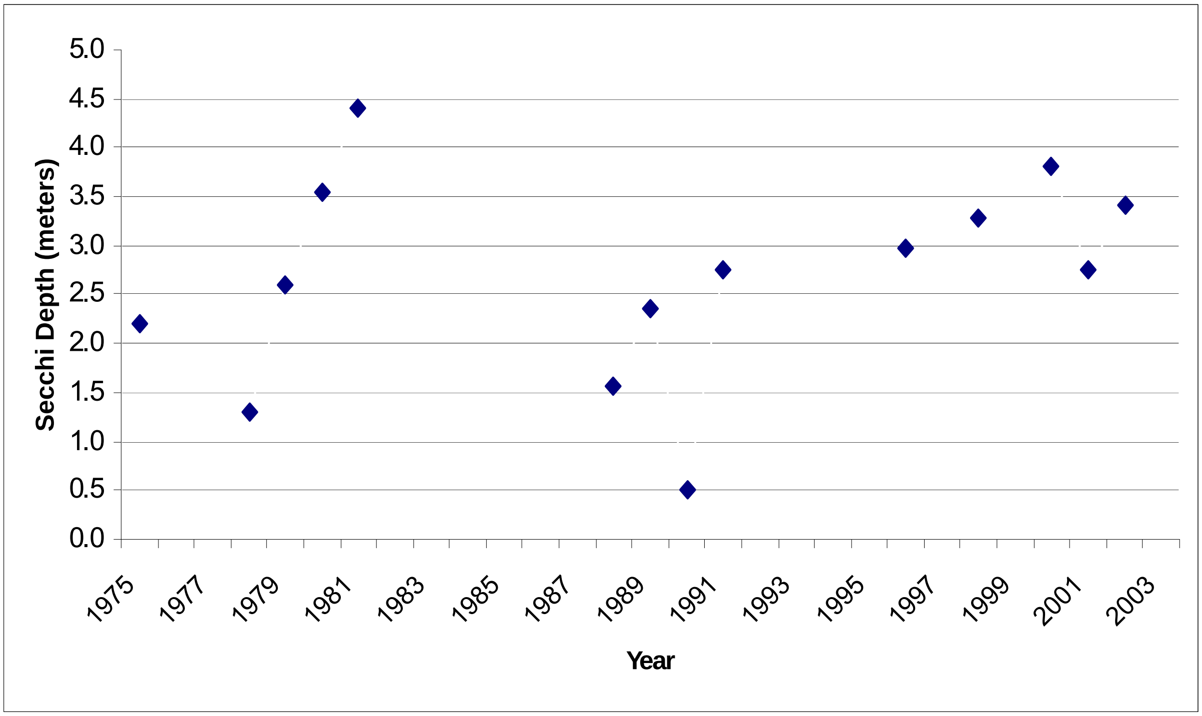


Figure 2.4 Mean summertime Secchi depths measured in Cascade Reservoir from 1975 through 2003.

prior to 1987, with a recent increasing trend. Some of the variability in Secchi depth measurement may stem from the diurnal nature of photosynthesis and the ability of blue-green algae to regulate water column elevation in response to environmental factors such as water temperature and solar radiance.

When compared to pre-implementation data, those data collected subsequent to implementation without question show an improving water quality trend within the reservoir. These data represent both wet and dry years and demonstrate to some extent the increased assimilative capacity associated with the improvement in water quality as dissolved oxygen, total phosphorus and chlorophyll a concentrations observed during an extreme low water year (2001) were much closer to target values than those observed during 1993 (an average to high-average water year) where the reservoir volume was much greater and water temperatures were lower.

Biological and Other Data

Waterbody Assessment Data Summary (BURP Data)

The Beneficial Use Reconnaissance Program (BURP) is a rapid bioassessment process that integrates biological and chemical monitoring with physical habitat assessment in order to assess stream integrity and support of beneficial uses. Information collected includes: water temperature, bank stability, riparian cover, substrate characterization, width/depth ratios, pool quality, bacteria samples, electrofishing, riffle/run prevalence, amount of large woody organic debris, and stream channel type. The water body assessment process uses ecological indicators calculated from BURP information to assess the support of aquatic life uses. Table 2.4 shows the metric scores for streams with BURP information in the watershed. The metrics are tailored for specific ecoregions. The three metrics (macroinvertebrates, fish and habitat) are looked at together to determine whether or not a waterbody supports its beneficial uses. The scores are based on comparison to reference percentile conditions. If the stream scores fall below the 10^{th} percentile of reference condition than the stream does not fully support beneficial uses. If any one of the individual metric scores fell below a minimum threshold of reference condition than the waterbody does not support beneficial uses. Table 2.5 shows the reference condition percentile scores for the Cascade Reservoir Watershed ecoregion.

Table 2.4 Beneficial Use Support Status of Watershed Streams

Support Status	Stream	SMI (bugs)	SFI (fish)	SHI (Habitat)	
FS	Gold Fork River	81.48122	n/a	60	1994
FS	Gold Fork River	72.82936		65	1994
FS	Gold Fork River	71.08264		49	1995
FS	Gold Fork River	68.25848		67	1995
NFS	Gold Fork River	64.73773		54	1998
FS	Gold Fork River (upper)	62.31554		80	1998
NFS	Mud Creek	34.11		27	1997
NFS	Mud Creek	9.02420	n/a	13	2001
NFS	Lake Fork	46.78481	16	47	1995
FS	Lake Fork	70.70252	n/a	54	1995
NFS	Willow Creek	26.03974	21	43	1995
NFS	Duck Creek	58.99606	n/a	50	1995
NV	Van Wyck Creek	70.33124	n/a	32	1994

NFS= not full support; NV=needs verification; FS=Full support

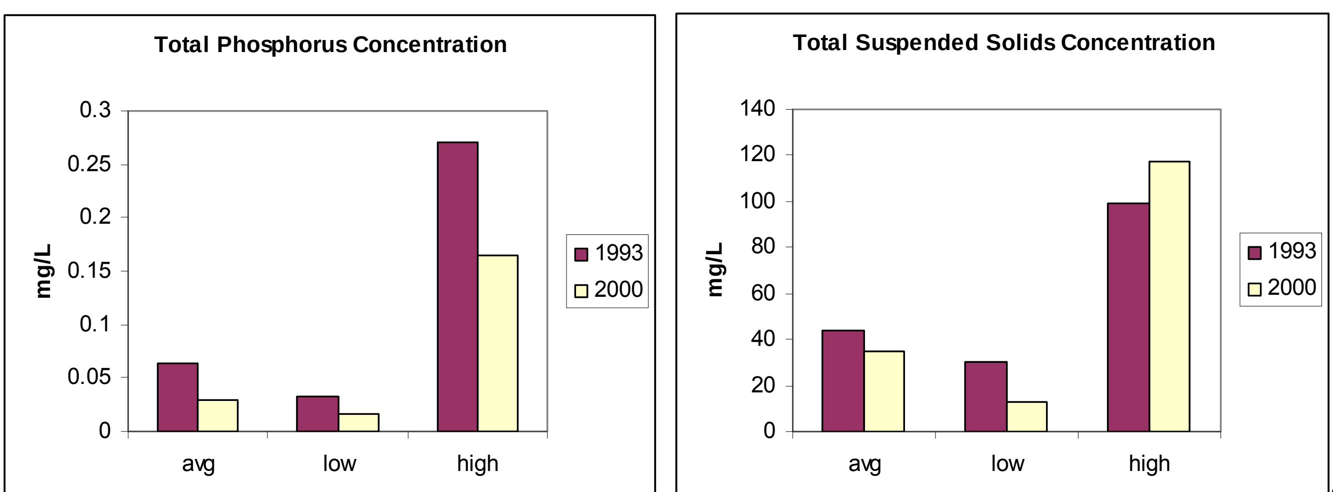
Table 2.5 Waterbody Assessment Reference Conditions

Condition Category	Stream Macroinvertebrate Index (SMI)	Stream Fish Index (SFI)	Stream Habitat Index (SHI)
Above the 25th percentile of reference condition	≥59	≥81	≥66
10th to 25th percentile of reference condition	51-58	67-80	58-65
Minimum to 10th percentile of reference condition	33-50	34-66	<58
Below minimum of reference condition	<33	<34	No criteria for this category

Status of Beneficial Uses

While data collected subsequent to TMDL implementation show a decreasing trend, concentrations are still routinely in excess of the total phosphorus target (0.025 mg/L). Median water column chlorophyll a concentrations are no longer observed to be routinely in excess of the target (10 ug/L) except in very late summer. These conditions demonstrate an improving trend in water quality within the reservoir. Similar trends are reflected in many of the tributary drainages. The data in Figure 2.5 and Table 2.5 compare 1993 and 2000 water quality data for the Cascade Reservoir Watershed. Flows for 1993 and 2000 are relatively similar (86% and 87% of the 30-year average respectively).

Figure 2.5 Comparison of mean total phosphorus and total suspended solids (TSS) concentrations



within the tributaries to Cascade Reservoir from 1993 (pre-implementation) and 2000 (partial implementation). (Note: The increase in high concentration TSS is due to a single, rapid snowmelt event within the watershed.)

The TMDL targets were identified to be protective of the designated beneficial uses within the watershed, therefore, until the targets are routinely met, full support of beneficial uses cannot be assumed. However, the improving water quality observed indicates that the magnitude of water quality impairment is decreasing. This improving trend translates to better overall habitat and use conditions, and is therefore representative of improving status conditions for designated beneficial uses.

Table 2.5 Mean total phosphorus and total suspended solids concentrations observed in tributaries to Cascade Reservoir in 1993 (pre-implementation) and 2000 (partial implementation).

Cascade Reservoir Tributary Monitoring	1993	2000
Average total phosphorus concentration	0.063 mg/L	0.029 mg/L
Total phosphorus concentration range	0.033 to 0.270 mg/L	0.016 to 0.164 mg/L
Average total suspended solids concentration	44.2 mg/L	34.6 mg/L
Total suspended solids concentration range	30 to 99 mg/L	13 to 117 mg/L

Conclusions

Based on the water quality trends identified since 1994, DEQ concludes that the implementation of the Cascade Reservoir Watershed Water Quality Management Plan is resulting in water quality improvements both in-reservoir and in the tributary systems, increased support of designated beneficial uses and improved resiliency of the reservoir. Full implementation is projected to result in routine attainment of water quality targets and full support of designated beneficial uses. Therefore, it is the recommendation of this (Phase III) TMDL that the current level of implementation be continued as outlined in the Cascade Reservoir TMDL Implementation Plan (DEQ, 2000).

2.4 Data Gaps

An existing data gap for the evaluation of total phosphorus loading to Cascade Reservoir has been identified within NFPR subwatershed. There is some concern that a considerable portion of NFPR total phosphorus load allocated to agricultural land uses in the Phase II TMDL may be due to streambank erosion-induced sediment loads rather than direct agricultural practices.

An additional data gap identified is the lack of instream monitoring data for the Cascade subwatershed. There are currently no consistently maintained monitoring sites within this subwatershed. Load and reduction allocations have been estimated using available information on land use practices and comparing specific land use acreages and flow volumes to other, similar subwatersheds for which comprehensive monitoring is available.

3. Subbasin Assessment – Pollutant Source Inventory

This document (Phase III) relies on the loading analysis and pollutant source inventories completed as part of the Phase II TMDL. A more in-depth discussion of identified pollutant sources in the Cascade Reservoir Watershed is available in the Phase II TMDL document (DEQ, 1998).

3.1 Sources of Pollutants of Concern

Pollutant loading analyses for the Cascade Reservoir Watershed were based on measured total phosphorus loads for water years 1993 to 1996. Figures 3.1, 3.2 and 3.3 illustrate the relative contribution of each identified source to the total phosphorus load entering Cascade Reservoir at the time the TMDL was completed. Table 3.1 provides a breakdown of the reduction goals within the watershed, first established in the Phase II TMDL (DEQ, 1998).

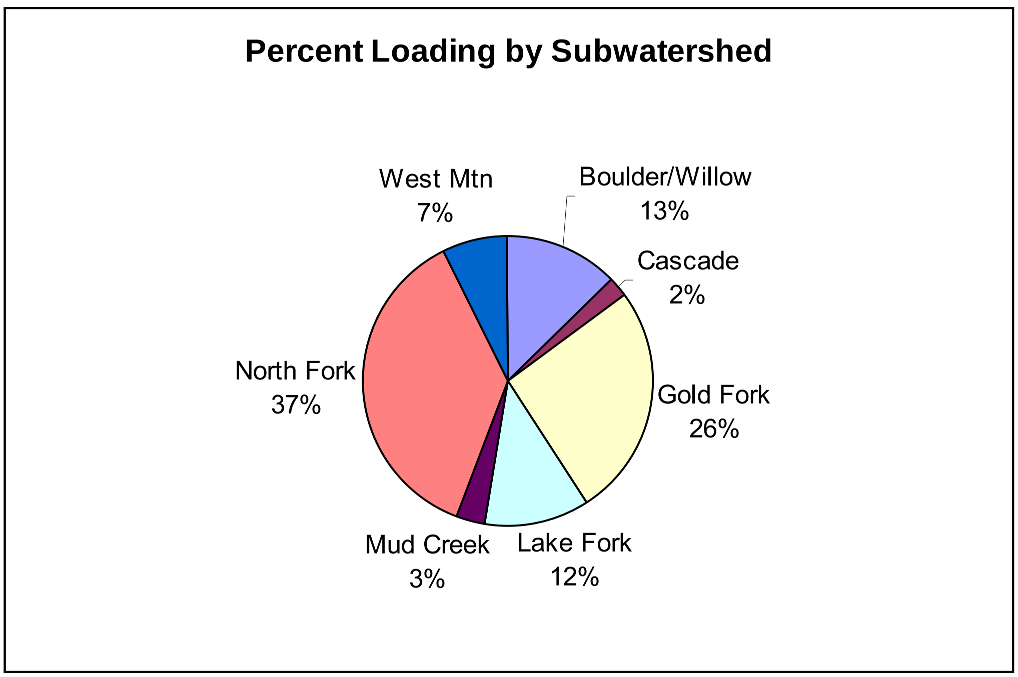


Figure 3.1 Total phosphorus loading identified by subwatershed in the Cascade Reservoir Watershed Phase II Water Quality Management Plan (TMDL).

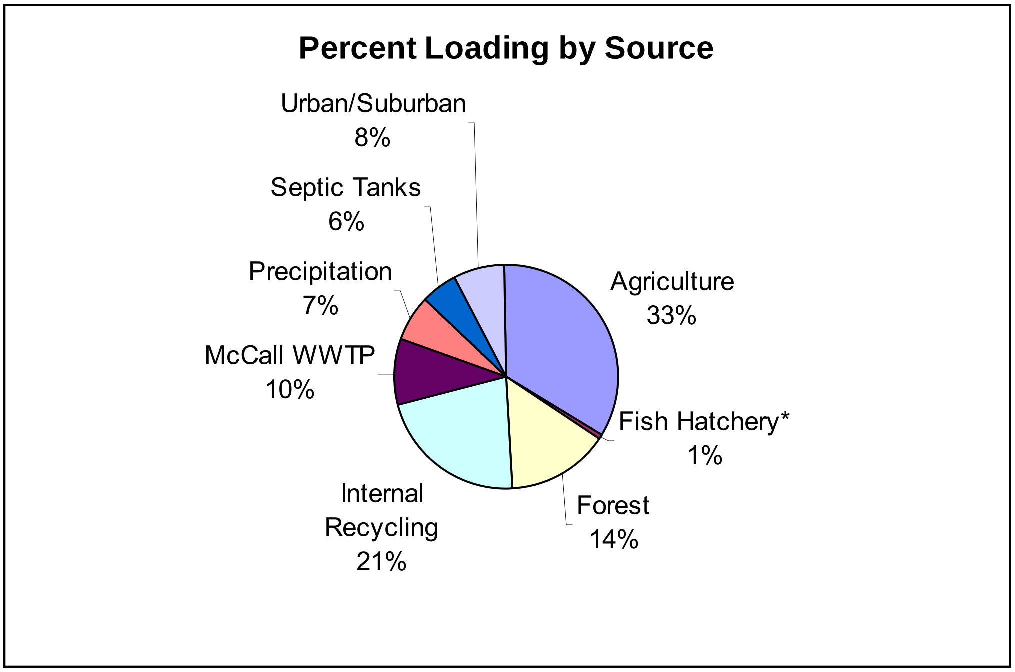


Figure 3.2 Total phosphorus loading identified by source in the Cascade Reservoir Watershed Phase II Water Quality Management Plan (TMDL).

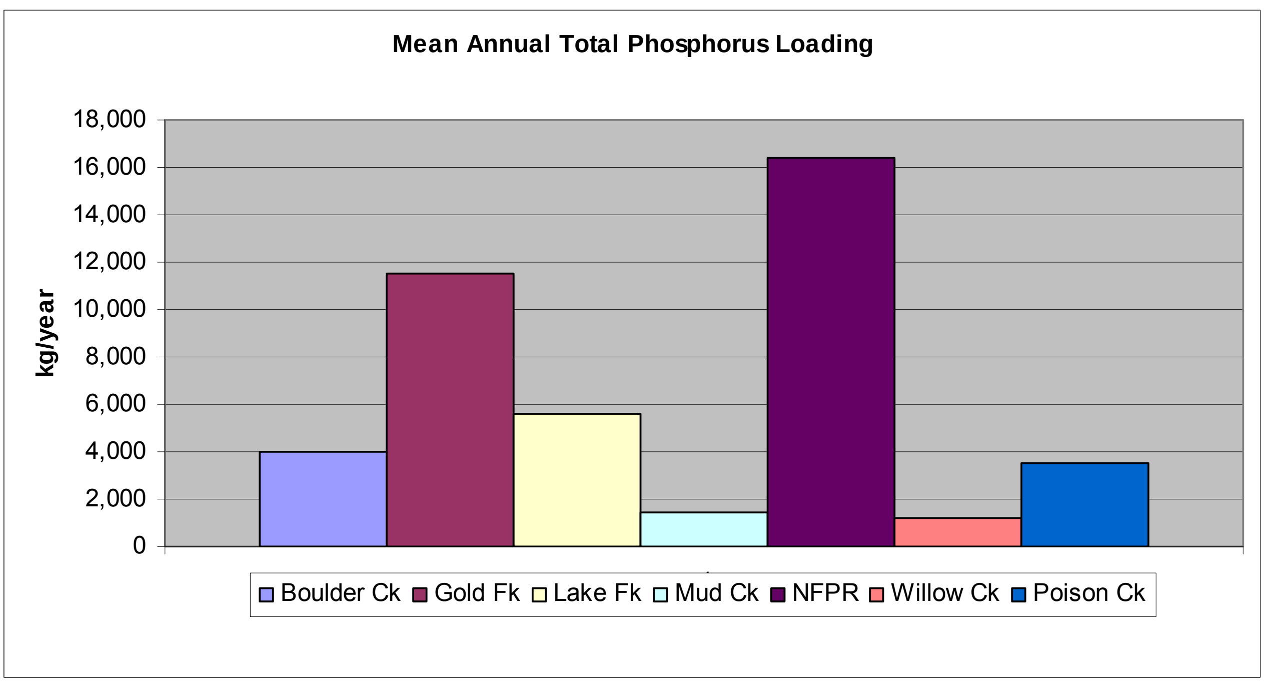


Figure 3.3 Average annual total phosphorus loading by tributary for the Cascade Reservoir Watershed (1995-1996).

Table 3.1 Annual total phosphorus load (kg/yr) to Cascade Reservoir averaged from 1993 through 1996 instream monitoring data. Loading was estimated using land use acreages updated to reflect changes through 2002.

Nonpoint Sources		**Measured Annual Phosphorus Load (kg/yr)**				
		Natural and Background	Forestry	Agriculture	Urban	Total
Subwatershed	Cascade[1]	209	2	218	236	666
	Gold Fork	4,704	3,164	741	64	8,673
	Lake Fork	600	126	2,276	946	3,948
	Mud Creek	167	8	610	250	1,035
	North Fork[1]	3,445	739	6,959	1,351	12,494
	West Mtn.	984	924	351	152	2,296
	Boulder/Willow	922	866	2,098	433	4,274
Septic[2]						2,205
Nonpoint Source Totals		11,031	5,668	13,252	3,433	35,590
Point Sources		**Measured Annual Phosphorus Load (kg/yr)**				
						Total
McCall Wastewater Treatment Plant						3,947
McCall IDFG Fish Hatchery						218
Point Source Totals						4,165
Grand Totals		11,031	5,668	13,252	3,433	39,755

[1] Monitoring data is not available for the Cascade Subwatershed, therefore total phosphorus loadings are estimates based on similar subwatersheds. In NFPR Subwatershed, a large portion of the measured total phosphorus loading cannot be directly attributed to point or nonpoint sources. Total loading is estimated at 12,494 kg/year, 6,959 kg/year of which have been tentatively allocated to agricultural land uses. However, this allocation is preliminary, and will be dependant on collection of additional data in NFPR Subwaterhshed. See *Identified Data Gaps* discussion in this document, and the in the Phase II TMDL (DEQ, 1998) for more information.
[2] Septic system loads and load reductions were calculated separately from the 30% nonpoint source load reductions and are not allocated specifically to any subwatershed.

Point Sources

At the time of the Phase I and Phase II TMDLs, there were two point sources of pollution to Cascade Reservoir, the McCall wastewater treatment plant (WWTP) and the IDFG fish hatchery in McCall. Both sources discharged directly to NFPR upstream of Cascade Reservoir under NPDES permits. A detailed discussion of each of these point sources is available in the Phase II TMDL (DEQ, 1998).

Major pollutants of concern associated with the WWTP discharge are nutrients, predominantly phosphorus. Effluent concentrations vary seasonally and typically exceed ambient concentrations in NFPR. Since 1988, annual total phosphorus discharge from the WWTP loading has remained relatively stable, ranging from 3815 kg to 4751 kg annually. In 2001 the WWTP completed a project to remove (100%) its effluent from NFPR. Since that time there has been no consistent discharge from this facility to NFPR.

Major pollutants of concern associated with the hatchery discharge are nutrients, again, predominantly phosphorus. In 1994 the fish food being used (1.7% phosphorus by weight) was replaced by a food type with lower phosphorus content (0.7% phosphorus by weight). This substitution was further augmented by changes in feeding practices. The combination of these changes has resulted in a substantially reduced phosphorus load since 1994. Pre-1994 total phosphorus loads were evaluated at 726 kg/yr (average). Post-1994 loads have been evaluated at 218 kg (average) total phosphorus annually.

The WWTP for the City of Cascade lies outside of the watershed for Cascade Reservoir. The City of Donnelly uses land application to dispose of treated effluent.

Nonpoint Sources

Major nonpoint sources of pollution in the Cascade Reservoir Watershed include forestry, agricultural and urban/suburban management practices; and internal recycling of nutrients within the reservoir. Due to the complexity inherent in the evaluation of nonpoint sources, each of these major categories was evaluated separately.

Forestry Management Sources

A total of 180,737 acres (65.4% of the total) are included in the forestry land use designation of the watershed. The majority of forested land (62%) is owned and administered by the USFS Boise and Payette National Forests. Other major forested-land owners/administrators include Idaho Department of Lands and private land-holders.

Forestry management practices include timber harvest and related activities such as road construction and use, timber removal, replanting and livestock grazing on forested allotments. Potential impacts from forested land sources include increased sediment load, increased erosion, vegetation reduction/removal, higher stream temperatures, destabilization of slopes, increased sediment transport in storm events and runoff. Potential sources of pollutant loading include road construction and use, landslides, soil creep, and livestock grazing on forested allotments. A detailed discussion of each of these potential sources is available in the Phase II TMDL (DEQ, 1998).

Forested land is present in all subwatersheds within the Cascade Reservoir Watershed and represents the major land use in all but the Cascade, Mud Creek and NFPR subwatersheds. In the Gold Fork and West Mountain subwatersheds forested land has been identified as the major contributor to total phosphorus load. These two subwatersheds, and NFPR subwatershed contain the majority of grazed forested land. These subwatersheds also have a large proportion of steeply-sloped, forested land that grades rapidly toward the valley floor, indicating the potential for rapid, highly efficient transport of both dissolved and sediment-bound phosphorus.

Agricultural Management Sources

A total of 64,170 acres of agricultural land use (23.2% of the total) are present in the watershed. Common agricultural management practices include grazing (livestock), and irrigated seed and pasture crops.

Potential impacts from agricultural sources include increased sediment load, increased erosion, vegetation reduction/removal, higher stream temperatures, increased sediment transport, soil compaction leading to reduced water infiltration, removal of soil fines from surface and subsurface, subsurface saturation, and decreased permeability and increased erosion from surface runoff. Potential sources of pollutant loading include poor grazing practices, poor irrigation management, and poor or over application of fertilizer. A detailed discussion of each of these potential sources is available in the Phase II TMDL (DEQ, 1998).

Agricultural land is present in all subwatersheds within the Cascade Reservoir Watershed and represents the major land use in the Cascade and Mud Creek subwatersheds. Agricultural land represents the major contributor to total phosphorus load in the Lake Fork, Mud Creek and Boulder/Willow subwatersheds. With the exception of Gold Fork, all subwatersheds contain a substantial amount of agricultural land in close proximity to the reservoir or tributaries discharging directly into the reservoir, indicating the potential for rapid, highly efficient transport of both dissolved and sediment-bound phosphorus.

Urban/Suburban Sources

Urban/suburban land use totals 31,474 acres (11.4% of the total) within the watershed. The largest portion of this acreage (45%) is within subdivisions, city impact areas account for 41% and the actual urban/city areas make up the remaining ~14%.

There are three primary components to the urban/suburban nonpoint-source pollutants: municipalities, rural residential subdivisions and their respective roads and highways and the transient (non-resident) tourist/recreation population. The transient population of the region has increased over the years and inevitably, increased the potential impact to urban runoff. Most of the impact is difficult to track and related to increased seasonal usage during the summer. Thus, calculated urban/suburban nonpoint source pollutant loading should be considered a conservative estimate.

Potential impacts from recreational uses are varied, ranging from increased erosion potential caused by irresponsible forest road and off-road vehicle use, to direct contamination of surface water by personal water craft or accidental fuel spills. Pollutants of concern generated by recreational uses include hydrocarbons from outboard motors, organic material from fish cleaning, potential bacterial contamination from human waste (improper sanitary disposal) and addition of nutrients, grease and oils from parking lot runoff at camp grounds and boat ramps. A detailed discussion of each of these potential sources is available in the Phase II TMDL (DEQ, 1998).

Internal Recycling and Reservoir Water Levels

Phosphorus contained in reservoir bed sediments also represents a substantial loading source to the water column, estimated to account for approximately 21% of the total phosphorus load. The deposition, release and dissolution of adsorbed phosphorus deposited in the reservoir is dependent on both physical and chemical processes. Physical processes dominate in the transport of phosphorus contained within or adsorbed to sediment and particulate. Chemical processes dominate in the transport of dissolved phosphorus and in the transformation of phosphorus from one form or state (i.e. free or adsorbed) to another. Low dissolved oxygen levels lead to sediment release of bound phosphorus due to induced changes in water chemistry.

Availability of sediment-bound phosphorus and potential leaching into surface water can also be affected by operational conditions controlling the water depth over the reservoir sediments. Fluctuating water levels that periodically expose lake sediments or alter the aerobic/anaerobic conditions at the sediment/water interface affect the sink/source characteristics of these sediments. Under annual drawdown conditions, sediment phosphorus availability may be increased, further contributing to the enrichment of the water column and increased algal productivity. Improved understanding of the sediment interactions has facilitated the current program of split summer/winter releases from Cascade Reservoir to augment the salmon-flush flow requirements.

4. Subbasin Assessment – Summary of Past and Present Pollution Control Efforts

Within the Cascade Reservoir Watershed, implementation has proceeded concurrently with the TMDL process, thus a considerable number of pollution control measures have been implemented, others are currently in progress. A more in-depth discussion of in-place, pending, and proposed implementation has been compiled in a formal implementation plan for Cascade Reservoir Watershed, *Cascade Reservoir Watershed TMDL Implementation Plan, DEQ,,2000).* This correlated implementation strategy is expected to result in progress toward the specified phosphorus reduction goal. Pollution control measures have been incorporated by all categories of land use.

The Cascade Reservoir TMDL Implementation Plan was compiled as a mechanism to identify and describe the specific pollutant controls and management measures to be undertaken, the mechanisms by which the selected measures will be put into action, and entities responsible for implementation projects.

The implementation plan established a yearly reporting scenario where the efforts and accomplishments of each source within the watershed would be highlighted. Information reported will also be used to measure progress on a source-specific basis and cost-efficiency for implementation measures. Point and nonpoint source progress and accomplishments during 2002 are outlined in the following sections.

4.1 Point Source Control Efforts

A unique combination of agricultural and urban/suburban efforts has been completed by agricultural land users in the Mud Creek subwatershed and the City of McCall. This project, named after the J-Ditch irrigation canal it replaces, allows treated effluent from the City of McCall to be mixed with clean water and applied at agronomic rates to pasture and crop land in the Mud Creek drainage during the summer irrigation season.

The completion of the J-Ditch project represents the 100% removal of the WWTP effluent from NFPR, as called for in the Phase I and II TMDLs. Effluent collected during non-irrigation season months is retained in storage lagoons constructed by the City of McCall and land-applied the following irrigation season. Agricultural land users participating in this project were originally using sub-flood irrigation practices. To date, all participants have installed on-farm sprinkler systems. As the mixed effluent is applied at agronomic rates, no adverse inputs or additional phosphorus loading within the Mud Creek subwatershed are projected to occur.

The discharge from the McCall WWTP has been out of NFPR since the summer of 2001. The McCall WWTP did not routinely discharge to NFPR during 2002. Final construction and minor modifications to the storage pond were on going during 2002.

The IDFG Fish Hatchery also discharges wastewater to the North Fork Payette River. Modifications to food type and feeding practices in 1994 and installation of a sediment pond to treat discharge water in 1999 have resulted in a 70+% reduction in the hatchery-related total phosphorus load. Current contributions account for less than 1% of the total phosphorus load. A maintenance and operation plan is required for this facility as part of formal NPDES permit renewals.

4.2 Nonpoint Source Control Efforts

Water quality improvement projects within the watershed have been divided into separate subwatersheds. These subwatersheds were given a priority ranking depending on how much phosphorus was being delivered to the reservoir, proximity to the reservoir, cost efficiency considerations and cost-benefit analyses, and other factors. The subwatersheds were ranked in order of priority (highest to lowest) as follows: Boulder/Willow, West Mountain, Lake Fork, Gold Fork, Mud Creek, Cascade, North Fork Payette River (not currently ranked). Within each subwatershed, projects are divided into three primary categories based on land use: forestry, agriculture, and urban/suburban. Some nonpoint source implementation projects currently underway are discussed in the source-specific sections that follow.

Forestry Control Efforts

The major source of anthropogenic total phosphorus loading from forested lands in the watershed has been identified to be from road-related sediment runoff and transport. In 2002, implementation by forestry nonpoint sources achieved 100% of their reduction goal for total phosphorus.

Forest Roads

Implementation measures completed for forestry sources specific to forest roads include over 109 miles of road treated, including 81 miles graveled, 3.5 miles closed, 24.7 miles of drainage upgrades and 0.1 miles paved. Estimated percent reductions in sediment and total phosphorus achieved are shown in Table 4.1. Additional road segments are currently scheduled for treatment.

Table 4.1 Estimated percent anthropogenic sediment and total phosphorus reductions from implementation of forest best management practices (BMPs) from 1994 though 2002.

Watershed	Sediment Reduction	Total Phosphorus Reduction
Boulder/Willow	84%	84%
Gold Fork	81%	81%
North Fork Payette	80%	80%
West Mountain	87%	86%
Watershed-wide Average Reduction	**82%**	**82%**

Grazing Management

Implementation measures completed specific to grazing management on forested allotments include a joint effort between Idaho Department of Lands (IDL), US Forest Service (USFS), Boise Cascade Corporation (BCC), and other private landowners to update and correlate grazing management plans. Nearly 100% of grazing allotments on public forested lands are now under grazing management plans. A schedule identified to address all grazing management plans will be completed in the near future. Dramatic improvements in stream bank vegetation have been observed in areas where grazing management plans have been put in place or updated. This is especially evident in the Gold Fork (where 80% reductions in total phosphorus have been observed) and West Mountain subwatersheds. Table 4.2 contains a summary of forestry implementation projects completed in 2002, and the associated reductions and costs.

Table 4.2 Estimated total phosphorus reductions achieved and associated costs of forestry implementation projects completed in 2002.

Project	Total Phosphorus Reduction	Sediment Reduction	Project Cost	Source of Funding
Hartzell Creek road improvements	48 kg/year	304 tons/year	$27,992	319 and private funds
Copeland Timber sale road and drainage improvements	4 kg/year	24 tons/year	$2,238	319 and private funds
Willow Creek road and drainage improvements	18 kg/year	117 tons/year	$10,800	319 and private funds
2002 Total	**70 kg/year**	**445 tons/year**	**$41,030**	

The total phosphorus reductions realized through implementation on forested lands were estimated from the efficiency of best management practices (BMPs) in place. Monitoring will continue to review applied BMPs. Additional road segments will continue to be treated as part of timber harvest activities or independently.

Agricultural Control Efforts

Despite funding delays and setbacks, implementation of new BMPs has been accomplished on 129 acres of agricultural land over the 2002 season, and maintenance and qualitative monitoring of existing BMPs has continued.

Treatment Prioritization

Treatment of agricultural acres was divided into a tiered system where Tier 1 acres (150 feet on either side of the steam channel) were identified as the first priority in treatment/implementation. Tier 2 acres (irrigated uplands) have been identified as the second priority in treatment and implementation. Tier 3 acres (non-irrigated uplands) have been identified as the last priority in treatment and implementation. Treatment of agricultural lands includes both irrigation and grazing management.

Grazing and Irrigation Management

For implementation projects on private lands, contracts were developed with private landowners to provide cost share to implement the conservation plan and approved BMPs. During 2002, 29 acres in Tier 1 were treated with treatment systems were developed for specific landowners. The 29 acres will be excluded from livestock grazing during the 10 year life of the contract. The systems applied within Tier 1 include the following practices: Fence, Use Exclusion and Tree/Shrub Establishment. During 2002, 100 acres in Tier 2 were treated and will be excluded from livestock grazing during the 10 year life of the contract. The systems applied within Tier 2 include the following practices: Tree/Shrub Planting, Wetland Wildlife Habitat Management, Upland Wildlife Habitat Management and Pest Management. Table 4.3 contains a summary of agricultural implementation projects completed in 2002, and the associated reductions and costs. Table 4.4 contains a summary of agricultural implementation progress to date.

The total phosphorus reductions realized through implementation on agricultural lands were estimated from the efficiency of BMPs in place. Monitoring will continue to validate estimated reductions in total phosphorus loading.

Urban/Suburban Control Measures

Pollutant control measures implemented for urban/suburban pollutant sources include stormwater management and roadway improvements.

Stormwater Management

Indirect treatment measures (wetlands) for the City of McCall, installed previously, are being maintained to treat stormwater discharging to NFPR. Additional work is scheduled for 2003-2004. Direct stormwater treatment measures (Vortechs technology, sand and gravel filters) for the City of McCall were installed in the Legacy Park area previously. This facility is being

Table 4.3 Estimated total phosphorus reductions achieved and associated costs of agricultural implementation projects completed in 2002.

Conservation Planning*	Tier	Acres	Project Cost	Source of Funding
Boulder/Willow subwatershed implementation	1 2 3	312 16 64	$4,502 $7,123	319 Grant EQIP
Gold Fork subwatershed	2	73		
Cascade subwatershed	2	50		
Project	**Total Phosphorus Reduction**	**Sediment Reduction**	**Project Cost**	**Source of Funding**
North Fork Payette subwatershed grazing management system on 29 Tier 1 acres	4.3 kg/year	27 tons/year	$13,333	WHIP and private funds
Boulder/Willow subwatershed grazing management system on 46 Tier 1 acres and 100 Tier 2 acres	16 kg/year (tier 1) 17 kg/year (tier 2)	102 tons/year 110 tons/year	$1,178 $3,084	319 Grant WHIP and private funds
2002 Total	**37 kg/year**	**239 tons/year**	**$29,220**	

* This report does not incorporate acres in the planning process or conservation plans developed, but not signed.

Table 4.4 Agricultural acres treated and/or cost shared by subwatershed through December 2002.

Subwatershed	Tier 1 Acres Treated	% Tier 1 Acres Treated	Tier 2 Acres Treated	% Tier 2 Acres Treated	Tier 3 Acres Treated	% Tier 3 Acres Treated	Total Acres Treated	Total Dollars
Boulder/Willow	183	29%	2,288	43%	0	0%	2,371	$ 798,141
Cascade	0	0%	180	5%	0	0%	180	$ 72,389
Gold Fork	213	24%	371	12%	0	0%	584	$ 196,710
Lake Fork	0	0%	386	9%	0	0%	386	$ 192,469
Mud Creek	131	24%	6,253	105%	0	0%	6,384	$1,332,269
NF Payette	34	3%	0	0%	0	0%	5	$ 14,779
West Mountain	0	0%	0	0%	0	0%	0	0
Totals	**561**	**9%**	**9,478**	**33%**	**0**	**0%**	**9,910**	**$ 2,606,757**

maintained to treat stormwater discharging to Big Payette Lake. An additional Vortechs system has been installed in the Art Roberts Park drainage area to treat stormwater discharging to Big Payette Lake. A street-sweeping program has been initiated and maintained to remove traction materials distributed throughout the winter. These materials are being removed from streets and gutters and deposited in a location where they will not be entrained in snowmelt flows and carried into the stormwater system. The Handbook of Stormwater BMPs, adopted by ordinance by the City of McCall and by resolution by Valley County, is recognized as being in need of update. Plans to appoint a committee to review the Handbook and make appropriate recommendations are in progress and the review should be completed in 2004.

Roadway Improvements

Numerous street and drainage improvements have been accomplished associated with road improvements to Highway 55 within the City of McCall. Drainage and surface improvements on county roads (watershed-wide) have been completed. Table 4.5 contains a summary of urban/suburban implementation projects completed in 2002, and the associated reduction efficiency and costs.

Table 4.5 Estimated total phosphorus reductions achieved and associated costs of urban/suburban implementation projects completed in 2002.

Project	Total Phosphorus Reduction	Sediment Reduction	Project Cost	Source of Funding
Stormwater treatment system installed near Art Roberts Park	75%	96%	$37,851	Idaho Dept of Transportation and City of McCall funds
Parking lot upgrade and drainage improvements	65+%	65+%	$ 43,664	City of McCall funds
Sweeping program for removal of traction materials	65+%	65+%	$9,000/year	City of McCall funds
2002 Total	**65+%**	**65+%**	**$ 90,515**	

The total phosphorus reductions realized through implementation on urban/suburban lands are estimated from the efficiency of BMPs in place. Monitoring will continue to validate estimated reductions in total phosphorus loading.

Other Nonpoint Source Control Efforts

Many other pollutant control efforts have been accomplished by state and federal agencies and private land owners throughout the watershed. A brief summary of some of these efforts follows.

US Bureau of Reclamation

Projects for shoreline erosion management, previously placed, are being maintained and are functioning well. Funding for additional projects is being actively sought. Created wetlands in the near-shore area of Cascade Reservoir have been augmented and are well vegetated. Monitoring of phosphorus reduction efficiencies for these wetlands is ongoing. The average treatment efficiency from these wetlands is highest for dissolved phosphorus. The data collected to date suggest that the wetland treatment efficiency is increasing as these systems continue to mature.

Idaho Parks and Recreation

A program to reduce burning and use chipping as a method of downed/damaged tree disposal has been introduced by Lake Cascade State Park. The chips and mulch produced are expected to be used to reduce erosion and encourage revegetation in heavy use areas. Leaking/poorly sealed vault toilets have been closed and decommissioned in VanWyck central and VanWyck north (two bathrooms, two seats each) including one composting toilet ($45,000) and one standard vault toilet ($20,000). Improved stormwater runoff treatment and drainage has been completed for some facilities. Additional improvements are scheduled for 2003-2004.

Interagency Cooperative Programs

Since 1995, a split-flow release for salmon augmentation water from Cascade Reservoir has been shown to be beneficial to water quality. Through 2000, a shaping agreement between Idaho Power Company and Bonneville Power Administration acted to promote the split flow release. This agreement expired in December 2000. Extremely low water levels occurring in the drought year of 2001 essentially prohibited salmon augmentation releases. A memorandum of understanding between the US Bureau of Reclamation and National Marine Fisheries was signed in 2002 to allow split flow releases to continue through 2002. This agreement was the product of political and interagency representatives, and the efforts of private citizens working together to further improve and protect water quality in the reservoir.

4.3 Summary of Total Phosphorus Reductions

Table 4.6 presents a summary of implementation actions completed to date and the relative percent of the required reductions that have been accomplished. Total phosphorus reductions for nonpoint sources are estimated from the efficiency of BMPs in place. Monitoring will continue to validate estimated reductions in total phosphorus loading. Additional work has been funded and is expected to be implemented in the coming year.

The current level of success enjoyed in the Cascade Reservoir Watershed is due to a high level of participation and commitment on the part of all point and nonpoint sources in the watershed. The reductions achieved have resulted in improved water quality conditions in the reservoir. Improved dissolved oxygen conditions have been observed in the reservoir in 1999, 2000, 2001 and 2002. Monitoring that has occurred since the early 1970s through the current time frame shows that water quality conditions are improving in the reservoir, and that positive trends in water quality have been observed since TMDL implementation started in 1994. Figures 2.2

Table 4.6. Summary of estimated total phosphorus loads and reductions for point and nonpoint sources within the Cascade Reservoir Watershed, 1994 through 2002.

	Total Load (kg/yr)	Projected Reduction (kg/yr)[1]	Reduction Achieved to Date (kg)	Percent of Reduction Achieved to Date
Point Sources				
McCall WWTP[2]	3,947	3,947	3,947	100%
IDFG Fish Hatchery	726	508	508	100%
Point Source Totals	4,673	4,455	4,455	100%
Nonpoint Sources				
Forestry[3]	8,681			
Roadways		1,436	1,579	108%
Grazing/Bank stabilization		1,168	1,096	92%
Total	8,681	2,604	2,675	101%
Agriculture	11,206			
Tier 1		824	100	12%
Tier 2		2,422	645	27%
Tier 3		116	0	0%
Total	11,206	3,362	745	21%
Urban/Suburban	4,990			
Roadways		830	200	27%
Stormwater		491	55	12%
Subdivision stormwater		176	?	?
Total	4,990	1,497	255	19%
Other				
Septic systems[4]	2,205	1,544	838[5]	54%
Unidentified NFPR	5,118	1,535	0	0%
Natural and background sources	3,390	599	80[6]	13%
Nonpoint Source Total	35,590	11,141	4,593	41%
Grand Total	**40,263**	**15,596**	**9,048**	**58%**

Reductions Achieved Before the Phase II TMDL

	Total Load (kg/yr)	Projected Reduction (kg/yr)	Reduction Achieved to Date (kg)	Percent of Reduction Achieved to Date
Point Sources				
IDFG Fish Hatchery	726	508	508	100%
Nonpoint Sources				
Septic systems	2,205	1,544	838[5]	38%

1. Contains management, natural and background loading.
2. Additional options for effluent use are being investigated to ensure that the system will operate with no discharge to North Fork Payette River in extreme water years
3. Implementation monitoring will continue to review applied BMPs. Additional road segments will continue to be treated as part of timber harvest activities or independently.
4. The reduction figure identified for septic systems is greater than the 30% required by the TMDL because of the fact that treatment has been identified as the construction of and hook-up to a wastewater treatment plant and therefore cannot be completed in an incremental fashion.
5. The 838 kg figure used assumes that all septic to sewer hookups completed included proper decommissioning of the septic tanks. This assumption has yet to be validated. Septic decommissioning is currently being evaluated.
6. Estimated from calculated transport to North Fork Payette River from Big Payette Lake.

through 2.4 illustrate the overall water quality trend information currently available for Cascade Reservoir.

The plot of mean summertime total phosphorus concentrations shown in Figure 2.2 illustrates a decreasing concentration trend since implementation of the Phase I TMDL started in 1994. A slight beak in trend is evident in 2001, an extremely dry year, but the overall slope of the trend line continues unbroken after 2001. A similar trend of decreasing concentration is evident in Figure 2.3, which shows a plot of mean summertime chlorophyll *a* concentrations. Once again, a slight break in trend is evident in 2001, but does not substantially influence the overall slope of the trend line. An increasing trend in water clarity is illustrated in Figure 2.4 indicating less suspended sediment and less algae growth in the reservoir. Algae growth also appears to occur over less of the reservoir surface.

The overall reduction goal for point source loading identified by the Phase II TMDL is 3,947 kg/year total phosphorus reductions. With the completion of the J-Ditch project, estimated point source reductions from this project equal 3,947 kg/year. When combined with the previous reductions accomplished by the IDFG Fish Hatchery, 100% of the total point source reduction goal has been accomplished.

The overall reduction goal for nonpoint source loading is 11,141 kg/year total phosphorus reductions, measured and estimated nonpoint source reductions (including reductions from septic to sewer upgrades) equal 4,593 kg/year (~41% of the nonpoint source goal). With the completion of implementation projects to date, forestry nonpoint sources achieved 100% of their reduction goal for total phosphorus.

Table 4.7 presents a summary of the estimated reductions and costs associated with the implementation actions completed to date for point and nonpoint sources on a land use basis. It also includes a breakdown of the relative calculated cost per kilogram over the projected lifetime of the identified projects. For several projects, the costs associated with implementation were not available or were estimated. In other projects, operations and maintenance costs were not available and were estimated. It should be recognized that the cost per kilogram calculated in Table 4.7 are, to some degree, approximations and will be refined as more information becomes available.

Table 4.7 Summary of estimated cost per kilogram of calculated total phosphorus reductions for point and nonpoint sources in the Cascade Reservoir Watershed TMDL.

	kg/yr	Total $	Estimated op. and maint. cost/year	Estimated $/kg/year over project lifetime
Point Sources				
McCall WWTP	***3,947***	***$9,996,000***	***$38,000***	***$136***
Nonpoint Sources				
Forestry				
roads	1,579	$1,719,214	$131,454	*$192*
grazing	1,096	$98,057	$44,050	*$49*
total	***2,675***	***$1,817,271***	**$175,504**	***$134***
Agriculture				
tier 1	100		$891	
tier 2	645		$13,875	
tier 3	0		$0	
total	***745***	***$452,470***	***$14,766***	***$81***
Urban/Suburban				
roadways	200	$138,600	$19,170	
urban stormwater	55	$235,711	$948	
subdivision stormwater	0		$0	
total	***255***	***$374,311***	***$20,118***	***$226***
Other				
septic systems	838	8,043,000	$5,320	*$486*
unidentified NFPR	0			
background sources	80	90,515	4,500	*$113*
total	***918***	***$10,777,565***		
Point Sources*	***3,947***	***$9,996,000***	***$38,000***	***$136 (average)***
Nonpoint Sources	***3,755***	***$2,734,567***	***$34,270 (avg)***	***$183 (average)***
Septic to Sewer Upgrades	***838***	***$8,043,000***	***$5,320***	***$436 (average)***
GRAND TOTAL	***8,540***	**$20,773,565**		***$252 (average)***

* This total does not include costs for the IDFG Hatchery improvements that have been completed.

Storage pond/application and septic to sewer upgrades are projected to have a 20 year lifetime. Other nonpoint source practices were projected to have a 10 year lifetime. These costs are not complete and should be considered draft at this time. Total expenditures, operations and maintenance and some other costs have not yet been accurately accounted for in some categories and in some subwatersheds.

5. Total Maximum Daily Load

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, which receive a load allocation (LA). Natural background (NB), when present, is considered part of the load allocation, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the MOS is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the LC is determined. Then the LC is broken down into its components: the necessary MOS is determined and subtracted; then NB, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation is completed we have a TMDL, which must equal the LC.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. Also a required part of the loading analysis is that the LC be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both LC and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads, and allow “gross allotment” as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 Instream Water Quality Targets

Cascade Reservoir is listed on Idahoэs 1998 303(d) list for nutrients, dissolved oxygen and pH. Phosphorus has been identified as the pollutant of concern within the reservoir. Phosphorus loading affects both dissolved oxygen and pH levels within the reservoir. High phosphorus concentrations result in excessive algae growth which impairs beneficial uses including fishing, swimming and boating. The decomposition of dead algae depletes dissolved oxygen within the water column, with the most severe effect occurring within the lower level of the water column as algae drift downward and accumulate on the bed sediments. Reduced dissolved oxygen levels result in a change in reduction-oxidation potential within the reservoir environment which in turn can lead to pH changes and further release of sorbed phosphorus from deposited bed sediments. Reduced dissolved oxygen levels, combined with warmer water temperatures in the summer months result in reduced fish habitat within the reservoir.

Because of the cause-and-effect relationship of phosphorus within the reservoir, phosphorus is being targeted specifically by this watershed management plan. Phosphorus loading modifications are addressed through the load allocations and reductions discussed below. Dissolved oxygen and pH modifications have been addressed through activities implemented for phosphorus load modification resulting in reduced algal growth.

Inlake water-quality targets are based on numerical standards for phosphorus (0.025 mg/L inlake total phosphorus concentration), chlorophyll a (10 μg/L inlake chlorophyll a concentration) and dissolved oxygen (concentrations exceeding 6 mg/L at all times, with the exceptions listed previously for the bottom 20% of water depth in lakes and reservoirs where depths are thirty-five (35) meters or less and those waters of the hypolimnion in stratified lakes and reservoirs). These objectives, based on water-quality modeling efforts for Cascade Reservoir, were set to achieve full support of designated beneficial uses (specifically fishing, swimming, boating and agricultural water supply). Pollutant loads were allocated as kg/year total phosphorus.

Reductions required are based on assessment of the maximum inlake load that can be sustained without beneficial use impairment. Reductions were assessed at the level required to achieve the inlake water-quality objectives for phosphorus concentration. Load capacity was divided among load allocations, waste-load allocations and a margin of safety.

When water-quality monitoring shows that water-quality standards have been met and beneficial uses are being fully supported, the watershed management plan will be successful.

Monitoring Points

An in-depth discussion of monitoring in the Cascade Reservoir Watershed is available in the Phase II TMDL (DEQ, 1998). Total and ortho-phosphate concentrations have been monitored consistently at the lower ends of each major tributary since 1993, and at a minimum of 4 inlake sites since 1992. Inlake sites are monitored during summer months by both the BOR and DEQ. A gross annual estimate of cumulative inflows to Cascade Reservoir is calculated by the BOR using the change in storage method. Stream flow and water quality within the tributaries have been measured at least monthly or biweekly during spring snow-melt (Zimmer, 1983, Entranco, 1991; DEQ, 1994; 1995; 1996; 1998).

5.2 Load Capacity

Load capacity is defined as the maximum load each waterbody can accommodate and still meet water quality standards with accommodation for seasonal variations and a margin of safety which takes into account any lack of knowledge (Clean Water Act § 303(d)(C)).

To evaluate load capacity for the reservoir, measured total phosphorus loads for water years 1993 to 1996 were utilized. Monitoring data was available for both tributary inflows and point sources. Some uncertainty was introduced by estimates made to interpolate missing flow data when direct stream measurements were not available for monitoring data. Interpolated flow values were evaluated for precision against total inflow and outflow data for Cascade Reservoir available from the BOR. This data set was used to calibrate and validate two water quality models specific to Cascade Reservoir. The revised Cascade Reservoir 1-D Model (Worth, 1997; Chapra, 1990) and the BETTER Model (Bender, 1997) were used to simulate changes in reservoir total phosphorus and chlorophyll *a* concentrations in response to changes in total phosphorus contributed by the subwatersheds.

Using a low-average water year and low-average reservoir water levels (350,000 acre feet as an absolute minimum volume), the total phosphorus load capacity for Cascade Reservoir was determined to be 25,039 kg/year.

5.3 Estimates of Existing Pollutant Loads

Monitored total phosphorus concentrations, tributary flows and point source discharge data from 1993 to 1996 were used to determine annual total phosphorus loading to Cascade Reservoir. The water years evaluated represent both above average and below average precipitation levels. Historical monitoring values for these years are available in Appendix D of the Phase II TMDL (DEQ, 1998).

Subwatershed loading calculations were evaluated through a review of previous studies and other available data (EPA, 1977; Zimmer, 1983; Entranco, 1991). Each of these studies offered monitoring information collected from the same general points of inflow to the reservoir as the current monitoring effort.

Annual estimates of phosphorus loading from nonpoint sources were observed to vary greatly from year to year. These differences may be related to differences in runoff conditions and errors in estimates of individual stream flow, concentration of nutrients and frequency of measurement. Sample locations, methods of measurement and frequency are most consistent among surveys conducted in water years 1993, 1994, 1995 and 1996. Highest rates of phosphorus loading were observed in 1993 (an above average year) which followed several consecutive years of below normal rainfall. Phosphorus loading in the Cascade Reservoir Watershed is observed to be closely tied to precipitation amounts and frequencies. Estimates of the point and nonpoint source total phosphorus loading to Cascade Reservoir are presented in Table 3.1 and Figures 3.1 through 3.3.

Nonpoint source runoff accounts for the majority of phosphorus input to the reservoir, averaging 83%. The largest portion (~37% average) of nonpoint source phosphorus is contributed by NFPR, due to its high flow volume (49% average of total inflow). Point source loading averages 10.3% of the total.

Phosphorus contribution from septic tank effluent was calculated in the Phase II TMDL (DEQ, 1998). All subdivisions with developed parcels within at least 600 feet of a waterbody were included. Estimates are based on the number of installed systems, usage and application of a phosphorus retention factor after Reckhow and Simpson (1980) (DEQ, 1996). The current estimate for septic tank effluent is 2,205 kg/yr total phosphorus based on a total of 1,795 septic tanks.

Contributions of total phosphorus from direct rainfall were based on precipitation data, applying a phosphorus content of rainfall (assumed equal to 0.05 mg/L) and multiplying by the volume of direct rainfall/snowfall in the water budget.

The internal recycling component of the total phosphorus loading to the reservoir was discussed earlier. This loading was estimated at approximately 8,700 kg/year total phosphorus using the revised Cascade Reservoir 1-D Model. Seasonal and annual variance associated with internal recycling are likely to be significant, and actual contributions are expected to vary considerably under differing limnological conditions.

Other potential contributions of phosphorus are associated with erosion of shorelines within the reservoir. The amount of the annual phosphorus loading attributed to this source was evaluated by the BOR using aerial photographs dating from 1988 to 1995. Phosphorus loading from shoreline erosion was not observed to be a significant contributor to the overall annual load.

Natural and Background Load Contributions

Natural sources of phosphorus are present within the watershed and contribute to the total phosphorus load measured within the reservoir and the tributaries. This natural loading is an important factor in the consideration of implementation strategy as it represents a phosphorus source that cannot be easily addressed by best management practices.

The calculation of natural contribution was specific to slope and vegetative cover throughout the subwatersheds (Table 5.1). Shallow-sloped land (<12%) within the Cascade Reservoir Watershed occurs mainly near the reservoir (on the valley floor) and is occupied predominantly by agricultural and urban/suburban land uses. Steeply-sloped land (>12%) occurs primarily within the forested areas of the watershed. Both literature and monitoring sources were used to determine the levels of phosphorus attributable to natural contribution within the watershed (Lindsay, 1979; McGeehan, 1996; Rasmussen, 1981; Reddy *et al.*, 1978; Sweeten and Reddell, 1978; Tiessen, 1995; Whiting *et al.*, 1997; USDA, 1992; Gilley *et al.*, 1992; Van Sickle, 1981; Swanson *et al*; Hoyt *et al.*,1978; Menzel *et al.*,1975; Omernik *et al.*, 1981).

Table 5.1 Annual natural total phosphorus contribution allocations by subwatershed (kg/yr) for the Cascade Reservoir Watershed.

Subwatershed	Acres	<12% Slope Contribution	≥12% Slope Contribution	Ground-Water Contribution	Total Contribution
Cascade	14,953	65	94	51	209
Gold Fork River	101,997	69	4,201	434	4,704
Lake Fork *	51,835	101	255	243	600
Mud Creek	13,097	99	0	68	167
NF Payette	31,264	106	493	1,129	**3,445
West Mountain	29,463	54	832	98	984
Boulder/Willow	33,772	123	720	79	922
TOTAL	**276,381**	**617**	**6,595**	**2,102**	**11,031**

***** Drainage area above Little Payette Lake was evaluated separately from the rest of the subwatershed as the lake acts as a sediment sink.
******Background sediment and phosphorus concentrations from Big Payette Lake were accounted for in addition to the natural contribution from the subwatershed.

The natural contribution from shallow-sloped acreages (<12%) was assessed as the sum of sheet and rill erosion (calculated using the USLE and RUSLE equations for pristine grassland conditions, USDA, 1992; Toy and Osterkamp, 1995) and snow-melt based erosion. The natural contribution of total phosphorus from steeply-sloped acreages (≥12%) was calculated using a combination of monitoring data available in subwatersheds with little or no recent management activities, aerial photos and landslide inventories from both the USFS and BCC, an extensive study on erosion in the Gold Fork subwatershed (BCC, 1996) and the BOISED model developed by the USFS for estimation of erosion based sediment loads. Cascade subwatershed has no available in-stream monitoring data. Therefore, loads were estimated from data available for similar, nearby subwatersheds.

Additional information on the estimation of background and natural loading is available in the Phase II TMDL (DEQ, 1998).

Land Use Changes – 1999 through 2002

It is recognized in the phased TMDL and implementation plan for Cascade Reservoir Watershed that land use distributions are not static. Data collected within the Cascade Reservoir Watershed show diminishing agricultural and forestry land use and increasing urban/suburban land use trends. It is acknowledged that changes in land use will continue to occur throughout the implementation process and into the future. The area of the watershed most vulnerable to this type of change is the valley floor and fringe areas along the foothills. Features such as view, topography, recreation potential, and access by public roads drives development decisions.

Valley County Planning and Zoning Conditional Use Permit applications during the 2002 calendar year were reviewed. Table 5.2 illustrates the reduction of forestry lands and agricultural lands by subwatershed.

The land use most affected by these changes is agriculture as the mechanisms used to allocate total phosphorus loads and assign required reductions were dependent on the acres of agricultural land use identified. The values in Table 5.2 indicate that of the 4,808 acres changed to urban-suburban land use in 2002, 1,453 acres were from agricultural lands (30%) and 3,355 acres from forested lands (70%). Overall, the land use changes identified for agricultural and forestry lands from April, 1999 through December 2002 represent a total decrease of over 5% in irrigated agricultural and pasture lands and over 2% in forested lands.

Table 5.2 Acres of land use changed from agriculture or forestry to urban/suburban 2000 through 2002 by subwatershed based on approved conditional use permits.

Change in Land use	Subwatershed							
	Boulder-Willow	Cascade	Gold Fork	Lake Fork	Mud Ck	NFPR	West Mtn.	Total
Agriculture to Urban/Suburban	701	142	17	539	46	59	670	2,174
Forest to Urban/Suburban	957	0	0	0	0	0	2,398	3,355
Overall Acres of Landuse Changed (2000 through 2002)	1,658	142	17	539	46	59	3,068	5,529

Table 3.1 reflects these land use changes in the total phosphorus loading values. Table 4.6 reflects these land use changes in the total phosphorus reductions required. As acreages continue to undergo changes in land use designation, these will be updated through the iterative TMDL process.

Tables 5.3 and 5.4 identify the wasteloads and loads identified by the TMDL process. The loads from nonpoint sources include natural and background total phosphorus loading. These loads are further detailed by subwatershed and nonpoint source category in Table 3.1.

Table 5.3. Wasteloads from point sources in Cascade Reservoir Watershed.

Wasteload Type	Location	Load	NPDES[1] Permit Number
McCall Wastewater Treatment Plant	On North Fork Payette River in McCall, Idaho	3,947 kg/year total phosphorus	ID0020231
IDFG Fish Hatchery	On North Fork Payette River in McCall, Idaho	218 kg/year total phosphorus	ID0025089

[1]National Pollutant Discharge Elimination System

Table 5.4. Loads from nonpoint sources in Cascade Reservoir Watershed.

Wasteload Type	Location	Load (kg/year)	Estimation Method
Forestry Sources	Cascade Reservoir Watershed	8,681	Measured data and modeling
Agricultural Sources	Cascade Reservoir Watershed	11,352	Measured data, NRCS guidelines and data from similar practices
Urban/Suburban Sources	Cascade Reservoir Watershed	4,990	Measured data and modeling
Other Nonpoint Sources			
Septic Systems	Cascade Reservoir Watershed	2,205	Measured and literature values
Unidentified NFPR	North Fork Payette River Subwatershed	5,118	Measured data
Other Natural and Background	Upstream Sources	3,390	Measured data

5.4 Load Allocation

The total phosphorus load capacity for Cascade Reservoir was about 25,000 kg/year, roughly 70% of the total phosphorus load measured. In order to not exceed the load capacity, a 30% overall total phosphorus load reduction is required.

Waste load allocations assigned by the Phase I and II TMDLS reflect full (100%) removal of the City of McCalls WWTP, and the changes in feeding management practices already in place for the IDFG fish hatchery. Load allocations assigned by the Phase I and II TMDLs reflect a 30% reduction of all nonpoint source total phosphorus loads. In all nonpoint-source load allocations, a 30% reduction of the total load (management load plus natural and/or background load) was determined to be possible from management sources alone.

It is recognized within this (Phase III TMDL) that efficient use of management efforts and available implementation monies should be of primary concern. Therefore, it is reasonable to expect that the 30% nonpoint source reduction goal may reached by implementation measures resulting in greater than 30% in some subwatersheds to offset less than 30% reductions in others. To this effect, it may be more cost-effective to eliminate or reduce certain significant pollutant sources, rather than reduce phosphorus from all sources equally. It is also possible that certain projects may present exceptional opportunities for achieving significant reductions, thus allowing other sources to seek less than a 30% reduction.

It is further recognized that if a particular source is unable to achieve its phosphorus reduction goal, other sources may need to make larger reductions to make up the difference. DEQ, in cooperation with the community, may look beyond site-specific load reductions and explore more cost-effective options to reduce pollutant loading from other sources in the watershed. This is known as pollutant trading. The Cascade Reservoir Coordinating Council and other work groups will be instrumental in identifying high priority and cost-effective load reduction projects that can be used for pollutant trading.

Margin of Safety

The maximum acceptable total phosphorus loading value generated by both mechanisms is about 70% of the averaged total phosphorus loading measured by instream tributary monitoring. Model simulations using a 30% reduction value were shown to result in substantially reduced algae growth which in turn resulted in improved dissolved oxygen and pH levels. Modeling showed this reduction level to be adequate to attain the required water-quality goals within the simulation period. To offset natural and operational variations, and account for uncertainty induced by interpolated concentration and flow values, an explicit 7% margin of safety was established. With the inclusion of the margin of safety, the required reduction in total phosphorus is 37%.

Seasonal Variation

Seasonal variability of flow and delivered phosphorus load is high. Concurrent evaluation of time/delivery plots for total phosphorus loading show that between 70% and 80% of the total phosphorus load is delivered to the reservoir during spring snow-melt and related precipitation events. The input of phosphorus during spring runoff and summer irrigation represents a critical time-step in the reversal of beneficial use impairment. Both represent increased sediment-bound total phosphorus and ortho-phosphate delivery and result in both long-term and immediately available phosphorus sources (respectively) within the reservoir water column. This time period should be heavily targeted in any implementation strategy.

Reasonable Assurance

For watersheds that have a combination of point and nonpoint sources where pollution reduction goals can only be achieved by including some nonpoint source reduction, a reasonable assurance that reductions will be met must be incorporated into the TMDL (EPA, 1991). The load reductions for the Cascade Reservoir Phase II Watershed Management Plan rely on nonpoint source reductions to meet the load allocations (LAs) to achieve desired water quality and to restore full support of designated beneficial uses.

To ensure that nonpoint source reduction mechanisms are operating effectively, and to give some quantitative indication of the reduction efficiency for in-place BMPs, monitoring will be conducted. If instream monitoring indicates an increasing total phosphorus concentration trend (not directly attributable to environmental conditions) or a violation of standards despite use of approved BMPs or knowledgeable and reasonable efforts, then BMPs for the nonpoint source activity must be modified by the appropriate agency to ensure protection of beneficial uses (Subsection 350.02.b.ii). This process is known as the "feedback loop" in which BMPs or other efforts are periodically monitored and modified if necessary to ensure protection of beneficial uses (Figure 3.8). With continued instream monitoring, the TMDL will initiate the feedback loop process and will evaluate the success of BMP implementation and its effectiveness in controlling nonpoint source pollution.

All identified point sources within the Cascade Reservoir Watershed are permitted facilities administered by the EPA. These facilities are located within the City of McCall. Wasteload (WLAs) reductions for both facilities are complete at this time.

The state has responsibility under Section 401 of the CWA to provide water-quality certification. Under this authority, the state reviews the projects to determine applicability to local water-quality issues.

Under Section 319 of the CWA, each state is required to develop and submit a nonpoint source management plan. Idaho's Nonpoint Source Management Program (Bauer, 1989) was submitted and approved by the EPA. The nonpoint management program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. Since the development of the Nonpoint Management Program in 1989, revisions of the water-quality standards have occurred. Many of these revisions have adopted provisions for public involvement, such as the formation of Basin Advisory Group (BAGs) and WAGs (IDAPA 16.01.02052), as discussed in section 2.1.2. The WAGs are to be established in high priority watersheds to assist DEQ and other state agencies in developing TMDLs and Watershed Management Plans (WMPs) for those segments.

The State of Idaho uses a voluntary approach to control agricultural nonpoint sources. However, regulatory authority can be found in the state water-quality standards (IDAPA 16.01.02350.01 through 16.01.02350.03). IDAPA 16.01.02054.07 refers to the Idaho Agricultural Pollution Abatement Plan (IAPAP) (IDHW, SCC, EPA; 1993) which provides direction to the agricultural community for approved BMPs. As a portion of the IAPAP, it outlines responsible agencies or elected groups (SCDs) that will take the lead if nonpoint pollution problems need addressing. For agricultural activity it assigns the local SCDs to assist the landowner/operator to develop and implement BMPs to abate nonpoint pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may provide injunctive relief for those situations that may be determined imminent and substantial danger to public health or environment (IDAPA 16.01.02350.02 (a)).

If a nonpoint pollutant(s) is determined to be impacting beneficial uses and the activity already has in-place referenced BMPs, or knowledgeable and reasonable practices, the state may request the BMPs be evaluated and/or modified to determine appropriate actions. If evaluations and/or modifications do not occur, injunctive relief may be requested (IDAPA 16.01.02350.2, ii (1)).

It is expected that a voluntary approach will be able to achieve LAs needed. Public involvement along with the eagerness of the agricultural community has demonstrated a willingness to implement BMPs and protect water quality. In the past, cost-share projects (many of which are cited in Appendix F) have provided the agricultural community technical assistance, information and education (I & E), and the cost share incentives to implement BMPs. The continued funding of these projects will be critical for the LAs to be achieved in the Cascade Reservoir Watershed.

In 1995 the State of Idaho passed Senate Bill 1284, now incorporated into the Idaho Code Section 39-3613 and Section 39-3615). This bill established the formation of the WAGs and BAGs to assist state and federal agencies with water-quality planning in high priority watersheds. The Cascade Reservoir Coordinating Council, which functions as the WAG for the Cascade Reservoir Watershed, was formed in January of 1995 in response to Idaho Code Section 39-3615 and public interest in the development of a TMDL for Cascade Reservoir. The Cascade Reservoir Coordinating Council was recognized as the representative body for the watershed by DEQ in that same year.

Natural and Background Loads

Natural sources of phosphorus are present within the watershed and contribute to the total phosphorus load measured within the reservoir and the tributaries. This natural loading is an important factor in the consideration of implementation strategy as it represents a phosphorus source that cannot be easily addressed by best management practices. The calculation of natural contribution was specific to slope and vegetative cover throughout the subwatersheds. Tabulated estimated values are available in Table 5.1.

Reserve

Due to the critical nature of the beneficial use impairment, a reserve capacity for total phosphorus was not established for this TMDL. If a new source wishes to discharge phosphorus load to the reservoir or watershed, the discharge will have to be offset by additional reductions in excess of the required 30% elsewhere in the watershed.

New sources will be required to meet the loading reductions for the land on which they intend to locate, in addition to meeting a no-net-increase in loading as described above.

Remaining Available Load

To accomplish the overall reduction, specific reductions in total and management phosphorus loads have been assessed for each subwatershed (Table 5.5 and 5.6). Point-source reductions totaling 7% of the total phosphorus load, and nonpoint-source reductions totaling 30% of the total phosphorus load (management load plus natural and/or background load) have been assigned on a subwatershed land use basis.

Table 5.5. Wasteload point source allocations for Cascade Reservoir Watershed.

Source	Pollutant	Allocation	Time Frame for Meeting Allocations
McCall Wastewater Treatment Plant	On North Fork Payette River in McCall, Idaho	100% removal of discharge	Completed
IDFG Fish Hatchery	On North Fork Payette River in McCall, Idaho	70% reduction to 218 kg/year total phosphorus	Completed

Table 5.6. Reductions in total phosphorus loading required from nonpoint sources in Cascade Reservoir Watershed.

Source	Pollutant	Required Reduction (kg/year)	Time Frame for Meeting Allocations*
Forestry Sources	Total phosphorus	8,681	Completed
Agricultural Sources	Total phosphorus	11,352	2013
Urban/Suburban Sources	Total phosphorus	4,990	2013
Other Nonpoint Sources			
Septic Systems	Total phosphorus	2,205	2013
Unidentified NFPR	Total phosphorus	5,118	2013
Other Natural and Background	Total phosphorus	3,390	2013

5.5 Implementation Strategies

An implementation plan for the Phase II TMDL was completed in 2000 (DEQ, 2000) and is 58% complete at this time. Please refer to the *Implementation Plan for the Cascade Reservoir Watershed Phase II Water Quality Management Plan* for further details of the implementation strategies being undertaken.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Time Frame

The expected time frame for meeting water quality standards and attaining full support of beneficial uses within the Cascade Reservoir Watershed was identified in the Phase II TMDL as 15 years from the completion of implementation. Due to exceptional participation of the part of nearly all pollutant sources, implementation is over 50% complete at this time. Water column concentrations of in-reservoir total phosphorus and chlorophyll *a* are nearing the water quality targets identified by the Phase II TMDL. Therefore, the original goal of implementation completion on or before 2013 seems viable. It should be noted however, that nonpoint source implementation is dependent on outside funding, without which, implementation cannot be completed. Therefore, completion of implementation by 2013 should be viewed as a goal, rather than a requirement.

Responsible Parties

The State of Idaho water-quality standards refer to other programs whose mission is to control nonpoint pollution sources. Some of these programs and responsible agencies are listed in Table 5.7.

5.6 Conclusions

Through implementation of management changes and BMPs undertaken by point and nonpoint sources within the Cascade Reservoir Watershed, water quality improvements are being realized.

Exceedences of the TMDL targets have occurred less frequently since the start of implementation, and median water column total phosphorus and chlorophyll *a* concentrations have consistently decreased in all years since 1994 except 2001 (an exceptional drought year). An increasing trend in water clarity is also forming (though not as well defined as that of the water chemistry indicators).

When compared to pre-implementation data, those data collected subsequent to implementation without question show an improving water quality trend within the reservoir.

While water quality targets are not met consistently within the reservoir, the improving water quality observed indicates that the magnitude of water quality impairment is decreasing. This improving trend translates to better overall habitat and use conditions, and is therefore representative of improving status conditions for designated beneficial uses.

Based on the water quality trends identified since 1994, it is the conclusion of DEQ that the implementation of the Cascade Reservoir Watershed Water Quality Management Plan is resulting in water quality improvements both in-reservoir and in the tributary systems,

Table 5.7 State of Idaho regulatory authority for nonpoint pollution sources.

Citation	IDAPA Citation	Responsible Agency
Rules governing Idaho forest practice	16.01.02350.03(a)	Idaho Department of Lands
Rules governing solid waste management	16.01.02350.03(b)	Idaho Department of Health and Welfare
Rules governing subsurface and individual sewage disposal systems	16.01.02350.03(c)	Idaho Department of Health
Rules and standards for stream channel alteration	16.01.02350.03(d)	Idaho Department of Water Resources
Rules governing exploration and surface mining operations in Idaho	16.01.02350.03(e)	Idaho Department of Lands
Rules governing placer and dredge mining in Idaho	16.01.02350.03(f)	Idaho Department of Lands
Rules governing dairy waste	16.01.02350.03(g) or IDAPA 02.04.14	Idaho Department of Agriculture

increased support of designated beneficial uses and improved resiliency of the reservoir. Full implementation is projected to result in routine attainment of water quality targets and full support of designated beneficial uses. Therefore, it is the recommendation of this (Phase III) TMDL that the current level of implementation be continued as outlined in the Cascade Reservoir TMDL Implementation Plan (DEQ, 2000).

References Cited

American Geologic Institute. 1962. Dictionary of geologic terms. Garden City, NY: Doubleday and Company. 545 p.

Armantrout, NB, compiler. 1998. Glossary of aquatic habitat inventory terminology. Bethesda, MD: American Fisheries Society. 136 p.

Batt, PE. 1996. Governor Philip E. Batt's Idaho bull trout conservation plan. Boise, ID: State of Idaho, Office of the Governor. 20 p + appendices.

Bauer, S.; 1989; *Idaho Nonpoint Source Management Program*; Idaho Department of Health and Welfare, Division of Environment, Boise, Idaho.

Beaty, K.G.; 1994; *Sediment Transport in a Small Stream following Two Successive Forest Fires*; Canadian Journal of Fisheries and Aquatic Sciences; Volume 51; Winnepeg, Canada; pp 2723-2733.

Bender, M.D.; Hauser, G.E.; Shiao, M.C.; Proctor, W.D.; 1997; *BETTER: A two-dimensional reservoir water quality model; Technical reference manual and user's guide;* Report Number WR28-2-590-152; Tennessee Valley Authority Engineering Laboratory, Norris, Tennessee; 160 p.

Big Payette Lake Water Quality Council (BPLWQC); 1998; *Big Payette Lake Management Plan and Implementation Program;* Big Payette Lake Water Quality Council, McCall, ID.

Bjornn, T.C.; Brusven, M.A.; Molnau, M.P.; Milligan, J.H.; Klamt, R.A.; Chacho, E.; Schaye, C.; 1977 (September); *Transport of Granitic Sediment in Streams and Its Effects on Insects and Fish*; University of Idaho, College of Forestry, Wildlife and Range Sciences; Bulletin Number 1; Moscow, Idaho; 43 p.

Boise Cascade Corp. (BCC); 1996 (December); *Gold Fork River Watershed Analysis*; Boise Cascade Corporation, Boise, Idaho; ~250 p + appendix.

Bureau of Reclamation; 1975; *Water Quality Studies, Payette River Basin and Cascade*; U.S. Department of the Interior, Bureau of Reclamation; 74 p.

Bureau of Reclamation; 1991 (June); *Cascade Reservoir Resource Management Plan*; Central Snake Projects Office, Boise, Idaho; 74 p.

Chapra, S.C.; 1990; *A Mathematical Model of Phosphorus, Chlorophyll a, Oxygen and Water Clarity for Cascade Reservoir*; Center for Advanced Decision Support for Water and Environmental Systems, University of Colorado, Boulder, Colorado; Final

Report to Entranco Engineers, Inc. and Idaho Department of Health and Welfare; 70 p.

Clark, W.H.; Wroten, J.W.; 1975; *Water Quality Status Report: Cascade Reservoir, Valley County, Idaho*; Water Quality Series Number 20; Idaho Department of Health and Welfare, Division of Environment, Boise, Idaho; 46 p + appendix.

Clean Water Act (Federal water pollution control act), U.S.C. § 1251-1387 (1972).

Entranco Engineers, Inc.; 1991 (January); *Cascade Reservoir Watershed Project Water Quality Management Plan*; Idaho Division of Environmental Quality, Boise, Idaho; 101 p + appendices.

Environmental Protection Agency; 1977; *Report on Cascade Reservoir, Valley County, Idaho*; Working Paper No. 777; U.S. Environmental Protection Agency, Corvallis, Oregon; 44 p.

Environmental Protection Agency; 1991; *Guidence for Water-Quality Based Decisions: The TMDL Process;* EPA 440/4-91-001; U.S. Environmental Protection Agency, Washington D.C.; 58 p.

EPA. 1996. Biological criteria: technical guidance for streams and small rivers. EPA 822-B-96-001. Washington, DC: U.S. Environmental Protection Agency, Office of Water. 162 p.

EPA. 1997. Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic updates: supplement. EPA-841-B-97-002B. Washington, DC: U.S. Environmental Protection Agency. 105 p.

Ferrari, R.L.; 1998 (May) revised; *Cascade Reservoir 1995 Sedimentation Survey*; USDI, Bureau of Reclamation, Sedimentation and River Hydraulics Group, Water Resource Services, Technical Service Center, Denver, Colorado.

Fischer, J.G.; Amacher, M.C.; Clayton, J.L.; *Dissolved and Sediment-bound Phosphorus Transport During Spring Snowmelt - Gold Fork River;* NPS Workshop Presentation; 1997; Boise State University, Boise, Idaho.

Gilley, J.E.; Kincaid, D.C.; Elliot, W.J.; Laflen, J.M.; 1992; *Sediment Delivery on Rill and Interrill Areas*; Journal of Hydrology; Volume 140; Amsterdam; pp 313-341.

Grafe CS, Mebane CA, McIntyre MJ, Essig DA, Brandt DH, Mosier DT. 2002. The Idaho Department of Environmental Quality water body assessment guidance, 2nd ed. Boise, ID: Department of Environmental Quality. 114 p.

Granger, D.E.; Kirchner, J.W.; Finkel, R.; 1996; *Spatially Averaged Long-Term Erosion Rates Measured from In Situ-Produced Cosmogenic Nuclides in Alluvial Sediment*; The Journal of Geology; Volume 104; Chicago, Illinois; pp 249-257.

Greenborg AE, Clescevi LS, Eaton AD, editors. 1992. Standard methods for the examination of water and wastewater, 18th edition. Washington, DC: American Public Health Association. 900 p.

Hedley, M.J.; Mortvedt, J.J.; Bolan, N.S.; Syers, J.K.; 1995; *Phosphorus Fertility Management in Agrosystems*; Chapter 5; Phosphorus in the Global Environment: Transfers, Cycles and Management; Tiessen, H.; (ed.); John Wiley and Sons, Chichester.

Hughes RM. 1995. Defining acceptable biological status by comparing with reference condition. In: Davis WS, Simon TP, editors. Biological assessment and criteria: tools for water resource planning. Boca Raton, FL: CRC Press. p 31-48.

Idaho Code § 3615. Creation of watershed advisory groups.

Idaho Code § 39.3611. Development and implementation of total maximum daily load or equivalent processes.

Idaho Department of Agriculture (ISDA); personal communication; May 1998; Boise, Idaho.

Idaho Department of Commerce (ISDC); personal communication; June 1998; Boise, Idaho.

Idaho Department of Health and Welfare (IDHW); 1996; *Water Quality Standards and Wastewater Treatment Requirements*; Idaho Department of Health and Welfare, Boise, Idaho.

Idaho Department of Health and Welfare (IDHW); Soil Conservation Commission (SCC); Environmental Protection Agency (EPA); 1993; *Idaho Agricultural Pollution Abatement Plan (IAPAP), Ag Plan*; Idaho Department of Health and Welfare; Soil Conservation Commission; Environmental Protection Agency; Boise, Idaho.

Idaho Division of Environmental Quality (DEQ); 1994; *Cascade Reservoir Data Summary - Water Year 1993*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Division of Environmental Quality (DEQ); 1995; *Cascade Reservoir Data Summary - Water Year 1994*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Division of Environmental Quality (DEQ); 1996 (January); *Cascade Reservoir Phase 1 Watershed Management Plan*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho; 86p + appendices.

Idaho Division of Environmental Quality (DEQ); 1996; *Cascade Reservoir Data Summary - Water Year 1995*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Division of Environmental Quality (DEQ); 1998; *Cascade Reservoir Data Summary - Water Year 1996*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Department of Environmental Quality (DEQ); 1998; *Cascade Reservoir Phase 1I Watershed Management Plan*; Idaho Department of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Department of Environmental Quality (DEQ); 2000 (June); *Implementation Plan for the Cascade Reservoir Phase 1I Watershed Management Plan*; Idaho Department of Environmental Quality, Boise Regional Office, Boise, Idaho.

IDAPA 58.01.02. Idaho water quality standards and wastewater treatment requirements.

Ingham, M.; 1992; *Citizen=s Volunteer Monitoring Program, Cascade Reservoir, Valley County, Idaho 1988-1991*; Water Quality Status Report Number 103; Idaho Department of Health and Welfare, Division of Environmental Quality, Boise Regional Office, Boise, Idaho; 17 p + attachments.

J.U.B. Engineers, Inc.; 1995; *Facility Plan Report, City of McCall*; Book 1, Chapters 1-5 (Two volumes); J-U-B Engineers, Inc., 250 S. Beechwood, Suite 201, Boise, Idaho.

Karr JR. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications 1:66-84.

Ketcheson, G.L.; 1986 (September); *Sediment Rating Evaluations: An Evaluation for Streams in the Idaho Batholith*; USDA, Forest Service, Intermountain Research Center; General Technical Report INT-213; Ogden, Utah; 12 p.

Khaleel, R.; Reddy, K.R.; Overcash, M.R.; 1980; *Transport of Potential Pollutants in Runoff Water from Land Areas Receiving Animal Wastes: A Review*; Water Research; Volume 14; Great Britain; pp 421-436.

Klahr, P.C.; 1988; *Lake Irrigation District Survey and Cascade Reservoir Tributary Assessment, Valley County, Idaho 1986*; Water Quality Status Report Number 79; Idaho Department of Health and Welfare, Division of Environmental Quality, Water Quality Bureau, Boise, Idaho; 46 p.

Klahr, P.C.; 1989; *Cascade Reservoir, Valley County, Idaho 1988*; Water Quality Status Report Number 85; Idaho Department of Health and Welfare, Division of Environmental Quality, Water Quality Bureau, Boise, Idaho; 12 p + appendix.

Lappin, J.L.; Clark, W.H.; 1986 (December); *An Assessment of Water Quality Impacts of Recreational Housing and Livestock Grazing in the Cascade Reservoir Watershed*; Journal of the Idaho Academy of Science; Volume 22; Number 2; pp 45-62.

Lindsay, W.L.; 1979; *Chemical Equilibria in Soils*; John Wiley and Sons, New York; pp 163-205.

Long Valley Advocate; September 15 and 29, 1993; weekly periodical; Stewart, M. (ed.); Poison Creek Publishing, Cascade, Idaho.

Mahoney, D.; Erman, D.C.;1984 (June); *An Index of Stored Fine Sediment in Gravel Bedded Streams*; Water Resources Bulletin; Volume 20; Issue 3; pp 343-348.

McGeehan, S.L.; 1996 (December); *Phosphorus Retention in Seasonally Saturated Soils Near McCall, Idaho (Final Report)*; University of Idaho, Division of Soil Science, Moscow, Idaho; 54 p + appendix.

Megahan, W.F.; 1972 (August); *Volume Weight of Reservoir Sediment in Forested Areas*; Journal of the Hydrolics Division, Proceedings of the American Society of Civil Engineers; Volume 98; Number HY8; pp 1335-1342.

Megahan, W.F.; 1976 (March); *Sediment Storage in Channels Draining Small Forested Watersheds in the Mountains of Central Idaho*; Proceedings of the Third Federal Inter-Agency Sedimentation Conference; Denver, Colorado; pp 4-115 to 4-126.

Megahan, W.F.; 1979; *Channel Stability and Channel Erosion Processes*; Workshop Proceedings: Scheduling Timber Harvest for Hydrolic Concerns; Portland, Oregon; November 27-29; 18 p.

Natural Resources Consulting Engineers, Inc. (NRCE); 1996 (September); *Analysis Summary Report: Cascade Reservoir Irrigation Management Plan*; Fort Collins, Colorado; 51 p.

North Lake Recreational Sewer and Water District (NLRSWD); Personal communication; May 1998.

Olness, A.; Smith, S.J.; Rhoades, E.D.; Menzel, R.D.; 1975; *Nutrient and Sediment Discharge from Agricultural Watersheds in Oklahoma*; Journal of Environmental Quality; Volume 4; Number 3; pp 331-336.

Omernik, J.M.; Abernathy, A.R.; Male, L.M.; 1981 (July-August); *Stream Nutrient Levels and Proximity of Agricultural and Forest Land to Streams: Some Relationships*; Journal of Soil and Water Conservation; pp 227-231.

Omernik, J.M.; Gallant, A.L.; 1986; *Ecoregions of the Northwest*; EPA/600/3-86/033; 39 p.

Platts, W.S.; Nelson, R.L.; 1995 (February); *Streamside and Upland Vegetation Use by Cattle*; Rangelands; Volume 7; Number 1; pp 5-7.

Rand GW, editor. 1995. Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition. Washington, DC: Taylor and Francis. 1125 p.

Rasmussen, L.M., 1981; *Soil Survey of Valley Area Idaho*; U.S. Department of Agriculture, Soil Conservation Service, Boise, ID; 146 p.

Reddell, D.L.; Johnson, W.H.; Lyerly, P.J.; Hobgood, P.; 1971; *Disposal of Beef Manure by Deep Plowing;* Livestock Waste Management and Pollution Abatement; ASAE Publication, Proceedings -271, ASAE; St. Joseph, Michigan; pp 235-238.

Reddy, G.Y.; McLean, E.O.; Hoyt, G.D.; Logan, T.J.; 1978; *Effects of soil, cover-crop and nutrient sources on amount and forms of phosphorus movement under simulated rainfall conditions*; Journal of Environmental Quality; Volume 7; Number 1; pp 50-54.

Reininger, B.; Rieman, B.; Horner, N.; 1983 (January); *Cascade Reservoir Fisheries Investigations*, Project F-73-R-4; Idaho Department of Fish and Game, Boise Idaho; 123 p.

Salminen, E.; Beschta, R.; 1991 (December); *Phosphorus and Forest Streams: The Effects of Environmental Condtions and Management Activities*; Department of Forest Engineering, Oregon State University, Corvallis, Oregon; 185 p.

Sharpley, A.N.; Hedley, M.J.; Sibbesen, E.; Hillbricht-Ilkowska, A.; House, W.A.; Ryszkowski, L.; 1995; *Phosphorus transfers from terrestrial to aquatic ecosystems*; Chapter 11, In Phosphorus in the Global Environment: transfers, cycles and management; Tiessen, H.(ed.); John Wiley and Sons, Chichester.

Sharpley, A.N.; Jones, C.A.; Grey, C.; Cole, C.V.; 1984; *A simplified soil and plant phosphorus model II: Prediction of labile, organic and sorbed phosphorus*; Soil Science Society of America Journal; Volume 48; pp 805-809.

Sharpley, A.N.; Smith, S.J.; Jones, O.R.; Berg, W.A.; Coleman, G.A.; 1992 (January-March); *The Transport of Bioavailable Phosphorus in Agricultural Runoff*; Journal of Environmental Quality; Volume 21; pp 30-35.

Shewmaker, G.E.; 1997; *Livestock Grazing Effects on Phosphorus Cycling in Watersheds*; Proceedings: Watershed and Riparian Workshop; LeGrand, Oregon; September 11-13; 25 p.

Sonzongni, W.C.; Chapra, S.C.; Armstrong, D.E.; Logan, T.J.; 1982 (October-December); *Bioavailability of Phosphorus Inputs to Lakes*; Journal of Environmental Quality; Volume 11; Number 4; pp 555-563.

Strahler AN. 1957. Quantitative analysis of watershed geomorphology. American Geophysical Union Transactions 38:913-920.

Swanson, F.J.; Janda, R.J.; Dunne, T.; *Summary: Sediment Budget and Routing Studies*; Proceedings; pp 157-165.

Sweeten, J.M.; Reddell, D.L.; 1978; *Nonpoint sources: state of the art overview*; Trans. ASAE; Volume 21; Number 3; pp 474-483.

Tiessen, H. (ed.); 1995; *Phosphorus in the Global Environment: Transfers, Cycles and Management*; Scientific Committee on Problems of the Environment (SCOPE) 54; John Wiley and Sons, Chichester.

Tilstra, J.R.; Malueg, K.W.; Larson, W.C.; 1972; *Removal of phosphorus and nitrogen from wastewater effluent by induced soil percolation;* J. Water Pollution Control Federation; Volume 44; Number 5; pp 796-805.

Toy, T.J.; Osterkamp, W.R.; 1995 (September/October); *The Applicability of RUSLE to Geomorphic Studies*; Journal of Soil and Water Conservation; Volume 50; Number 5; pp 498-503.

United States Department of Agriculture (USDA); 1992 (April); *Agricultural Wastes and Water, Air and Animal Resources*; Agricultural Waste Management Field Handbook; USDA ; Part 651, Chapter 3; Washington, DC; pp 3-8 to 4-11.

United States Forest Service (USFS); 1998 (March); *Cascade Reservoir Watershed Analysis Report*; United Stated Department of Agriculture, Forest Service, Intermountain Region, Boise National Forest, Casade Ranger District, Cascade Idaho.

USGS. 1987. Hydrologic unit maps. Denver, CO: United States Geological Survey. Water supply paper 2294. 63 p.

Van Sickle, J.; 1981(June); *Long Term Distributions of Annual Sediment Yields From Small Watersheds*; Water Resources Research; Volume 17; Number 3; pp 659-663.

Water Pollution Control Federation. 1987. The Clean Water Act of 1987. Alexandria, VA: Water Pollution Control Federation. 318 p.

Water Quality Act of 1987, Public Law 100-4 (1987).

Water quality planning and management, 40 CFR 130.

Western Regional Climate Center (WRCC). 2003. On-line long-term weather and climatological data repository. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?idcasc

Whiting, P.J.; Matisoff, G.; Bonniwell, E.C.; 1997 (July); *Phosphorus Radionuclide Tracing of Fine Sediment in Forested Watersheds*; Case Western Reserve University, Department of Geological Sciences, Cleveland, Ohio; 39 p + appendices.

Worth, D.; 1993-1994; *Cascade Reservoir and tributary water quality data*; Unpublished data; Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho.

Worth, D.; 1997; *Cascade Reservoir Model: Model Simulations of External Reductions in Phosphorus Loading to Cascade Reservoir*; for Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho; 17 p.

Worth, D.; 1998; personal communication; May 1998; Boise, Idaho.

Worth, D.; Lappin, J.; 1994; *Blue-green algae blooms on Cascade Reservoir, Valley County, Idaho;* Envir. Health Digest; Volume XX; Number 1; pp 18-21.

Zimmer, D.W.; 1983 (August); *Phosphorus Loading and Bacterial Contamination of Cascade Reservoir, Boise Project, Idaho*; Boise Project Power and Modification Study; USDI, Bureau of Reclamation, Pacific Northwest Region, Boise, Idaho; 143 p.

GIS Coverages:

Restriction of liability: Neither the state of Idaho nor the Department of Environmental Quality, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information or data provided. Metadata is provided for all data sets, and no data should be used without first reading and understanding its limitations. The data could include technical inaccuracies or typographical errors. The Department of Environmental Quality may update, modify, or revise the data used at any time, without notice.

Add list of GIS coverages to end of references (see guidance).

Glossary

305(b)	Refers to section 305 subsection "b" of the Clean Water Act. 305(b) generally describes a report of each state's water quality, and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.
§303(d)	Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of waterbodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.
Acre-Foot	A volume of water that would cover an acre to a depth of one foot. Often used to quantify reservoir storage and the annual discharge of large rivers.
Adsorption	The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules
Aeration	A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.
Aerobic	Describes life, processes, or conditions that require the presence of oxygen.
Assessment Database (ADB)	The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of waterbodies, and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.
Adfluvial	Describes fish whose life history involves seasonal migration from lakes to streams for spawning.
Adjunct	In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

Alevin	A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a waterbody, living off stored yolk.
Algae	Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.
Alluvium	Unconsolidated recent stream deposition.
Ambient	General conditions in the environment. In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations, or specific disturbances such as a wastewater outfall (Armantrout 1998, EPA 1996).
Anadromous	Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the salt water but return to fresh water to spawn.
Anaerobic	Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.
Anoxia	The condition of oxygen absence or deficiency.
Anthropogenic	Relating to, or resulting from, the influence of human beings on nature.
Anti-Degradation	Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.56).
Aquatic	Occurring, growing, or living in water.
Aquifer	An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.
Assemblage (aquatic)	An association of interacting populations of organisms in a given waterbody; for example, a fish assemblage, or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).
Assimilative Capacity	The ability to process or dissipate pollutants without ill effect to beneficial uses.
Autotrophic	An organism is considered autotrophic if it uses carbon dioxide as its main source of carbon. This most commonly happens through photosynthesis.

Batholith	A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.
Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic biota, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
Beneficial Use Reconnaissance Program (BURP)	A program for conducting systematic biological and physical habitat surveys of waterbodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers
Benthic	Pertaining to or living on or in the bottom sediments of a waterbody
Benthic Organic Matter.	The organic matter on the bottom of a waterbody.
Benthos	Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms.
Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
Best Professional Judgment	A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.
Biochemical Oxygen Demand (BOD)	The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.
Biological Integrity	1) The condition of an aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).
Biomass	The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.
Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.

Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria).
Colluvium	Material transported to a site by gravity.
Community	A group of interacting organisms living together in a given place.
Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (µ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Cretaceous	The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. EPA develops criteria guidance; states establish criteria.
Cubic Feet per Second	A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.
Cultural Eutrophication	The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication).
Culturally Induced Erosion	Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).
Debris Torrent	The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains.

Decomposition	The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.
Depth Fines	Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 mm depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 cm).
Designated Uses	Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).
Dissolved Oxygen (DO)	The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.
Disturbance	Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.
E. coli	Short for *Escherichia Coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.
Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
Ecological Indicator	A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.
Ecological Integrity	The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).
Ecosystem	The interacting system of a biological community and its non-living (abiotic) environmental surroundings.
Effluent	A discharge of untreated, partially treated, or treated wastewater into a receiving waterbody.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Eocene	An epoch of the early Tertiary period, after the Paleocene and before the Oligocene.
Eolian	Windblown, referring to the process of erosion, transport, and deposition of material by the wind.
Ephemeral Stream	A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table. (American Geologic Institute 1962).
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Eutrophic	From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.
Eutrophication	1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.
Existing Beneficial Use or Existing Use	A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).
Exotic Species	A species that is not native (indigenous) to a region.
Extrapolation	Estimation of unknown values by extending or projecting from known values.
Fauna	Animal life, especially the animals characteristic of a region, period, or special environment.
Fecal Coliform Bacteria	Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria).
Fecal Streptococci	A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.
Feedback Loop	In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.
Fixed-Location Monitoring	Sampling or measuring environmental conditions continuously or repeatedly at the same location.

Flow	See Discharge.
Fluvial	In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.
Focal	Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.
Fully Supporting	In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
Fully Supporting Cold Water	Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions (EPA 1997).
Fully Supporting but Threatened	An intermediate assessment category describing waterbodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a "not fully supporting" status.
Geographical Information Systems (GIS)	A georeferenced database.
Geometric Mean	A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.
Grab Sample	A single sample collected at a particular time and place. It may represent the composition of the water in that water column.
Gradient	The slope of the land, water, or streambed surface.
Ground Water	Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.
Growth Rate	A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.
Habitat	The living place of an organism or community.
Headwater	The origin or beginning of a stream.
Hydrologic Basin	The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle	The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.
Hydrologic Unit	One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.
Hydrologic Unit Code (HUC)	The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.
Hydrology	The science dealing with the properties, distribution, and circulation of water.
Impervious	Describes a surface, such as pavement, that water cannot penetrate.
Influent	A tributary stream.
Inorganic	Materials not derived from biological sources.
Instantaneous	A condition or measurement at a moment (instant) in time.
Intergravel Dissolved Oxygen	The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.
Intermittent Stream	1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.
Interstate Waters	Waters that flow across or form part of state or international boundaries, including boundaries with Indian nations.
Irrigation Return Flow	Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams.

Key Watershed	A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.
Knickpoint	Any interruption or break of slope.
Land Application	A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.
Limiting Factor	A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.
Limnology	The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.
Load Allocation (LA)	A portion of a waterbody's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).
Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Loading Capacity (LC)	A determination of how much pollutant a waterbody can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.
Loam	Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.
Loess	A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.
Lotic	An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth.
Luxury Consumption	A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a waterbody, such that aquatic plants take up and store an abundance in excess of the plants' current needs.
Macroinvertebrate	An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.

Macrophytes	Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.
Margin of Safety (MOS)	An implicit or explicit portion of a waterbody's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving waterbody. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.
Mass Wasting	A general term for the down slope movement of soil and rock material under the direct influence of gravity.
Mean	Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.
Median	The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; and 6 is the median of 1, 2, 5, 7, 9, 11.
Metric	1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.
Milligrams per liter (mg/L)	A unit of measure for concentration in water, essentially equivalent to parts per million (ppm).
Million gallons per day (MGD)	A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.
Miocene	Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.
Monitoring	A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a waterbody.
Mouth	The location where flowing water enters into a larger waterbody.
National Pollution Discharge Elimination System (NPDES)	A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.
Natural Condition	A condition indistinguishable from that without human-caused disruptions.

Nitrogen	An element essential to plant growth, and thus is considered a nutrient.
Nodal	Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing waterbodies that have been studied, but are missing critical information needed to complete an assessment.
Not Attainable	A concept and an assessment category describing waterbodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).
Not Fully Supporting	Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
Not Fully Supporting Cold Water	At least one biological assemblage has been significantly modified beyond the natural range of its reference condition (EPA 1997).
Nuisance	Anything, which is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
Nutrient Cycling	The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).
Oligotrophic	The Greek term for “poorly nourished.” This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.
Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.

Orthophosphate	A form of soluble inorganic phosphorus most readily used for algal growth.
Oxygen-Demanding Materials	Those materials, mainly organic matter, in a waterbody that consume oxygen during decomposition.
Parameter	A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.
Partitioning	The sharing of limited resources by different races or species; use of different parts of the habitat, or the same habitat at different times. Also the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment.
Pathogens	Disease-producing organisms (e.g., bacteria, viruses, parasites).
Perennial Stream	A stream that flows year-around in most years.
Periphyton	Attached microflora (algae and diatoms) growing on the bottom of a waterbody or on submerged substrates, including larger plants.
Pesticide	Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
Phased TMDL	A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a waterbody. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
Physiochemical	In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the terms "physical/chemical" and "physicochemical."

Plankton	Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment that alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Pretreatment	The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.
Primary Productivity	The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training. The goal of QA is to assure the data provided are of the quality needed and claimed (Rand 1995, EPA 1996).
Quality Control (QC)	Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples. QC is implemented at the field or bench level (Rand 1995, EPA 1996).
Quantitative	Descriptive of size, magnitude, or degree.
Reach	A stream section with fairly homogenous physical characteristics.

Reconnaissance	An exploratory or preliminary survey of an area.
Reference	A physical or chemical quantity whose value is known, and thus is used to calibrate or standardize instruments.
Reference Condition	1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).
Reference Site	A specific locality on a waterbody that is minimally impaired and is representative of reference conditions for similar waterbodies.
Representative Sample	A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.
Resident	A term that describes fish that do not migrate.
Respiration	A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.
Riffle	A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a waterbody.
Riparian Habitat Conservation Area (RHCA)	A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams: - 300 feet from perennial fish-bearing streams - 150 feet from perennial non-fish-bearing streams - 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.
River	A large, natural, or human-modified stream that flows in a defined course or channel, or a series of diverging and converging channels.
Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

Settleable Solids	The volume of material that settles out of one liter of water in one hour.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a waterbody.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
Stream	A natural watercourse containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.
Storm Water Runoff	Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.
Stressors	Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.
Subbasin	A large watershed of several hundred thousand acres. This is the name commonly given to 4th field hydrologic units (also see Hydrologic Unit).
Subbasin Assessment (SBA)	A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.
Subwatershed	A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.
Surface Fines	Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 mm depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff	Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.
Surface Water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.
Suspended Sediments	Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.
Taxon	Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).
Tertiary	An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.
Thalweg	The center of a stream's current, where most of the water flows.
Threatened Species	Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
Total Maximum Daily Load (TMDL)	A TMDL is a waterbody's loading capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual basis. TMDL = Loading Capacity = Load Allocation + Wasteload Allocation + Margin of Safety. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several waterbodies and/or pollutants within a given watershed.
Total Dissolved Solids	Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS) The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Greenborg, Clescevi, and Eaton 1995) call for using a filter of 2.0 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary A stream feeding into a larger stream or lake.

Trophic State The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

Total Dissolved Solids (TDS) Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS) The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Greenborg, Clescevi, and Eaton 1995) call for using a filter of 2.0 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary A stream feeding into a larger stream or lake.

Trophic State The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

Turbidity A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Vadose Zone The unsaturated region from the soil surface to the ground water table.

Wasteload Allocation (WLA) The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a waterbody.

Waterbody	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Column	Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.
Water Pollution	Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.
Water Quality	A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.
Water Quality Criteria	Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Limited	A label that describes waterbodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.
Water Quality Limited Segment (WQLS)	Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."
Water Quality Management Plan	A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.
Water Quality Modeling	The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality.
Water Quality Standards	State-adopted and EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.
Water Table	The upper surface of ground water; below this point, the soil is saturated with water.

Watershed	1) All the land that contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region, which contributes water to a point of interest in a waterbody.
Waterbody Identification Number (WBID)	A number that uniquely identifies a waterbody in Idaho ties in to the Idaho Water Quality Standards and GIS information.
Wetland	An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.
Young of the Year	Young fish born the year captured, evidence of spawning activity.

Appendix A. Unit Conversion Chart

Table A1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft^2) Square Miles (mi^2)	Hectares (ha) Square Meters (m^2) Square Kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (g) Cubic Feet (ft^3)	Liters (L) Cubic Meters (m^3)	1 g = 3.78 l 1 l = 0.26 g 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 g = 11.35 l 3 l = 0.79 g 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (ft^3/sec)[1]	Cubic Meters per Second (m^3/sec)	1 ft^3/sec = 0.03 m^3/sec 1 m^3/sec = ft^3/sec	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[2]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 kg
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 ° C = 37.4 °F

[1] 1 ft^3/sec = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 ft^3/sec.
[2]The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.